AIR POLLUTION

A BIBLIOGRAPHY

By S. J. Davenport and G. G. Morgis

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AIR POLLUTION
A BIBLIOGRAPHY

By
S. J. Davenport and G. G. Morgis

INTRODUCTION

REVIEW of voluminous literature reveals that air pollution has been a vital issue for centuries. The antiquity of the problem is indicated by the ancients' belief that wandering particles in the air played an important role in the development of disease, especially fevers. Undoubtedly this was the origin of the "miasmatic" theory that infectious, contagious, foul, and noxious material floating in the air, especially in the night mist, caused disease. The great fires that were lighted at the entrances and exits of cities had for their object the burning of these miasmata by establishing a virtual barrage to prevent their propagation.

Before the discovery of fire, air pollution probably was due to natural sources, such as the eruption of volcanoes, dust raised by wind, and smoke emanating from burning forests set afame by lightning. Dust and fumes from the eruption of volcanoes have traveled around the world and caused a general haziness of the atmosphere over the Northern Hemisphere, for periods as long as 2 years in the instance of the Katmai eruption of 1902-3; even this was markedly less than that ejected from the great Krakatoa eruption in 1883.

A more recent instance of the distance traveled by air pollution is that of the smoke from the huge forest fires raging in Alberta and the Mackenzie district in Canada in 1951. During this period a minister in Ashtabula, Ohio, is said to have chosen as subject for his Sunday sermon "The End of the World" and described how the end would come "in an orange glow." He did not say when; however, his parishioners, while driving home, experienced a terrific shock when they discovered the sky suffused with a weird yellow light. They were not the only persons that day to worry about the world's ending. Smoke blown from these huge fires spread an enormous, sun-stifling pall over the United States from Chicago to Philadelphia. In different localities the sky glowed with strange copper, pink, and blue tones. In this unreal darkness at noon, the birds retired for the night, and airport beacons were lighted. In Cleveland and other cities lights in baseball and football parks had to be turned on so the games could be played.

An interesting instance of the effects on man of pollution of the air by volcanic eruption is told by the Roman historian, Tacitus. According to him, Pliny the Younger gave the following account of the death of his uncle, Pliny the Elder:

On August 24, 80 A.D., the attention of Pliny the Elder, who was living at Misenum, was called to a cloud of unusual size and shape ascending from a mountain in the distance. This phenomenon seemed to him to be worth looking into and he ordered a vessel to take him near to it. As he was about to board the vessel he received word from a friend whose villa was situated at the foot of Mount Vesuvius, telling him of the great danger from which there was no escape except by way of the sea. Pliny immediately changed his first intention and attempted to go to the aid of the towns in the danger area along the coast. He landed at Stabiae on a bay that separated the town

1 Work on manuscript completed April 1953.
2 Publications writer (Medical Sciences), Health Branch, Bureau of Mines, Washington, D. C.
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from Mount Vesuvius, intending to put to sea again if the danger there should increase. However, the wind and the immense waves, which were unfavorable to putting him ashore, prevented him from leaving.

According to Pliny the Younger his uncle had a weak throat, which was often inflamed and which probably made him susceptible to the vapors. Three days after the eruption the body of Pliny the Elder was found entire without any marks of violence upon it, in the clothes in which he fell, and looking more like a man asleep than dead. The death of Pliny under the circumstances described would seem to be an early example of the fact that the pollution of the air by noxious gases, such as sulfur compounds, is more dangerous for people suffering from respiratory diseases.

With the discovery of fire and its utilization for domestic and industrial heating, man-made air pollution has increased, especially with the great industrial development, until its abatement has become in many instances an all-important problem demanding solution.

Before complaints were made of air polluted by smoke, which began with the use of coal as a fuel in England, Theophrastus, a pupil of Aristotle (in his History of Stones, published about 371 B.C.), said that fossil substances called coals burned for a long time, but the smell was troublesome and disagreeable. The people of London and vicinity were greatly aroused when, in 1288, the lime burners conceived the idea of substituting coal for the wood and charcoal formerly used in their furnaces. Complaint was made to Edward I, who ordered his officers, in conjunction with the city sheriffs, to seek a remedy. Further complaint was made in 1307, and sea coal was especially impugned, severe penalties being enacted for its use. Chased from London by the fumes, William III changed his residence to Kensington in 1690. During the reign of Queen Elizabeth, the ladies of the land supported her dislike of sea coal, and many would not enter houses where it was burned or partake of a meal cooked over a sea-coal fire. To the end of Queen Elizabeth's reign, coal was used mainly by artisans and the poor, who could not afford to buy wood.

As long ago as the days of Horace (65 B.C.), the poet lamented that the shrines of Rome were blackened by smoke. The deleterious and costly effects of air pollution on buildings are brought forcefully to attention by a chemical engineer, who cited the crumbling of the Parthenon. For 2,400 years this temple of Athena has dominated the Acropolis overlooking Athens, Greece; recently this "architect's dream" has been crumbling at an ever-increasing rate, as if some disease were affecting the close-grained marble pillars and cornices. So rapid is the decay that expert observers estimate that 200 years from now hardly a trace of the Parthenon will remain. The decay is blamed on "the corrosive breath of twentieth-century Athens, principally the sulfur dioxide in the smoke-polluted air."  

The first regulation on smoke in England appeared in 1343. According to the American Municipal Association, only four cities in the United States of more than 25,000 population have not established some air-pollution control. All present up to $120,000,000 is said to be spent annually in the United States by industry and municipalities to combat air pollution.

At the general meeting of the United States Technical Conference on Air Pollution in Washington, D.C., May 3–5, 1950, a resolution was presented recommending that the "organization be undertaken of existing and current literature on all phases of atmospheric pollution so that everyone may be aware of the work of those in other phases. Publication might be in toto or in abstract form." The following bibliography has been prepared by members of the Health Branch of the Bureau of Mines at the request of the chairman of the conference mentioned.

This bibliography, which is confined strictly to outdoor atmospheric pollution, has been arranged according to subjects, with the abstracts under each subject in chronological order, arranged alphabetically by authors. As many of the articles reviewed contained material on several phases of air pollution,

* Newsweek, Monumental Disease: Vol. 35, 1950, pp. 60, 63.
an effort was made to place each abstract under the subject that was most emphasized; thus, some overlapping was unavoidable. Titles of reports enclosed in brackets are translations from the original language of publication.

Many sources have been used in preparing the bibliography, including bibliographies issued earlier. Where the abstracts have been adapted from other bibliographic sources credit is given by adding the abbreviations of the publication in parentheses at the end of the abstracts.

One of the following abbreviations after an abstract indicates the source of that particular abstract:

<table>
<thead>
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<th>Description</th>
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<tr>
<td>AIHOM</td>
<td>Archives of Industrial Hygiene and Occupational Medicine, pub. by American Medical Association, Chicago, Ill.</td>
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<tr>
<td>BH</td>
<td>Bulletin of Hygiene, pub. by Bureau of Hygiene and Tropical Medicine, London, England.</td>
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<tr>
<td>BP</td>
<td>British Patent.</td>
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<tr>
<td>CA</td>
<td>Chemical Abstracts, pub. by American Chemical Society, Washington, D. C.</td>
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<tr>
<td>CLAC/UCLA</td>
<td>County of Los Angeles, Calif., and University of California, Los Angeles.</td>
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<tr>
<td>JHD</td>
<td>Industrial Hygiene Digest, pub. by the Industrial Hygiene Foundation, Pittsburgh, Pa.</td>
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<tr>
<td>IHF</td>
<td>Industrial Hygiene Foundation, Mellon Institute, Pittsburgh, Pa.</td>
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<tr>
<td>JHID</td>
<td>Journal of Industrial Hygiene Digest, pub. by Industrial Hygiene Foundation, Mellon Institute, Pittsburgh, Pa.</td>
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<tr>
<td>JIHT</td>
<td>Journal of Industrial Hygiene and Toxicology, pub. by the Harvard School of Public Health; united on Jan. 1, 1950, with Archives of Occupational Medicine, now published by the Am. Med. Assoc. as Archives of Industrial Hygiene and Occupational Medicine.</td>
</tr>
<tr>
<td>MIR</td>
<td>Mellon Institute of Industrial Research of the University of Pittsburgh, Pittsburgh, Pa.</td>
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GENERAL ASPECTS OF AIR POLLUTION

1859

Discusses atmospheric pollution in towns in a comprehensive manner. Methods of combustion of coal and its byproducts are tabulated. Sulfur acids produced cause stunting of tree growth. The acidity of the air at times is so great as to turn litmus paper red immediately during a rain. Estimates of carbonic acid and organic matter in air are discussed. The death rate is higher in urban areas because of atmospheric pollution.

Based on experiments in which polluted air was bubbled through blood, the conclusion is that "the atmosphere of a town has a peculiar effect on the state of the blood." (USPHS) 1882


Reference is made to the strong language used by the people at the time of the introduction of coal into England regarding the disagreeable nature of coal smoke. The people of those days had not become accustomed to the extremely disagreeable atmosphere now being breathed.

The phenomenon known as dry fog, which is observed when the atmosphere is not saturated, is directly connected with the impurities in the atmosphere. These impurities check the evaporation of the water in the atmosphere.

Two main factors are discussed as the causes of the evil. These are the production of smoke in manufacturing operations and in inhabited houses.

The various methods that may be applied to meet the two requisites for perfect combustion are described. It was agreed, however, that the human stoker was more at fault than the appliances at his command.

The use of gas is suggested as one way to control the problem. 1891


Reviews, papers, and discussions at the meeting of the Seventh International Congress of Hygiene and Demography are included. (MR—Bib.) 1893


The enormous use of coal and the constant increase in chemical works, furnaces, and other industries cause injuries that cannot be overlooked. Works hide their processes of manufacture and the kind and quantity of materials employed to prevent recognition of the kind and amount of damage being done.

On the other hand, gardens are purposely planted with expensive ornamental flowers, which are unsuited to the climate and have no chance of prospering, to profit by the damages from destruction by smoke.

The principal source of damage is said to be SO₂, but evident signs of injury through HF have been noted frequently.

Following a discussion of the injury done to vegetation, the statement is made that the task of the expert is to discover the extent to which each works is responsible for the damage. 1895


Bituminous coal was introduced as a fuel in the thirteenth century, but in 1306 a decree was passed forbidding its use. Many authorities are cited against the use of coal from this time on, including Count Rumford. The police and other regulations are given, with the percentages of punishment for their infractions. The subjects discussed are the content of sulfur and carbon monoxide, the size of chimney, and the amount of soot deposited in some places. The average deposit about 4,500 m.², or nearly 1,000 tons, of soot, equal to 20 kg. of soot daily in each km², or 0.69 grain per square yard. A fuel without sulfur should eliminate a powerful element in city fogs. The sulfur compounds rather than soot are the cause of fogs.

In a part of London where coal is used mainly for domestic purposes 730 grains SO₂ were found in 1,000,000 cu. ft. of air. In Manchester 1,008 grains were found and in St. Helens 1,290 grains. It was calculated in 1879 that the fire gases escaping into the air at St. Helens per week contained 500 tons SO₂; copper works, 350 tons SO₂; glass works, 180 tons SO₂; and alkali works, 25 tons HCl.

The inspectors sometimes find that a larger quantity of sulfuric anhydride escapes from coal combustion than is allowed to escape from sulfuric acid works. 1899


England holds the foremost place among the nations of Europe as regards general sanitation, but in the matter of smoke and its resultant thick yellow fog it is at the other extreme. Nowhere else is the air so charged with smut, are fogs so noisome, are buildings so soot-begrimed, are trees and herbage so blasted, is sunshine so short and feeble.

The cost of air pollution is so great that a truly practical and commercial nation would put an end at once to such heavy items of expense. Unfortunately, however, these items cannot be expressed accurately in pounds, shillings, and pence, and careless people cannot be brought to understand the magnitude of a loss that cannot be defined simply.

The waste of fuel is one contributor to the smoke nuisance. It is due generally to faulty construction of the fire grates in which the coal is burned. The adoption of better fire grates probably would reduce the consumption of coal one-sixth and the emission of smoke to an even greater degree. The adoption of such fire grates would save a saving of hard cash of £2,000,000 in London alone. The waste of gas and electricity, the laundry bills, and the damage to painting, trees, plants, and flowers,
and other expenses due to smoke and fog are itemized. All efforts should be directed to the collection of information and its publication to educate the public.


Increase in smoke is due to exhaustion of wood and use of coal; its sources are factory-boiler and domestic fires. If the population of London is assumed to be 5½ million, then 2 million domestic chimneys could be assumed to smoke between 7 a.m. and 11 p.m. during winter and half a million in summer. Most smoke is given off from 7 to 9 in the morning, when fires are lighted. A reasonable assumption is that the amount of smoke given off is equal to that in a chimney 1,000 ft. square.

Restaurants are the greatest offenders, and their number is increasing inordinately.

Smoke is the result of chemical decomposition of coal with insufficient air for complete combustion. Its unburnt tarry constituents make up the principal part of smoke. Smoke should be abolished for sanitary reasons.

Causes of smoke and method of prevention are discussed.

Recommendations of an English smoke commission (1881), a German smoke commission (1894), and a Paris commission (1894) are cited.

1900


The widespread effect of smoke is insufiiciently realized. Dwellers in towns often are so hardened to it as to be almost oblivious to its presence. The great smoke-producing districts of the North of England, its extent, and miserable condition of vegetation in some parts of the area are cited. Amount of smoke varies according to the season. Reduction of air transparency causes dimness of sky and landscape. Other points discussed are: Distance to which smoke travels; mistake of smoke for haze; red sunsets in southeast Yorkshire; atmosphere of the North of England; lack of brilliance north of the smoke area with southerly winds; smoke from Barrow-in-Furness, an isolated town, and distance at which this is noticeable; comparison of volume of smoke from this town with that from the great smoke area; characteristic smell from certain lakes and distance at which it can be detected; discoloration of rainwater, “black rain”; influence of smoke on sunshine, air temperature in calm summer weather and in anticyclonic weather during autumn and winter, and low day-temperature maximums; smoke and fog production; long-continued smoke fog of February 1890; darkness in and around large cities; effect of smoke on mosses and heathies as compared with that of plants of higher order; smoke at a maximum in winter, when many mosses are in a vegetative condition; great diminution in their abundance and luxuriance in the neighborhood of large towns; peculiar exposure of bark-loving species to smoke influence and the cause; threatened extinction of Ulotra and Orthotricha.

1901


1902


Editorial review dealing respectively with conditions in St. Louis and Cleveland. (MIR—Bib.)

1903


Brief general summary from “Deutsche Revue.” (MIR—Bib.)


A very general description is given of the formation of smoke, the methods that have been used to determine its density, and the smoke recording instruments in use at that time.


The origin of smoke, signs of smoke injury, proof of smoke injury to vegetation, and effects on animals are discussed. Effects of various gaseous constituents of smoke are cited from the literature.

It is concluded that the establishment for all parts of a country of a permissible percentage of injurious products that may be emitted would not be practicable. In Germany each separate case is judged by itself. As the prevailing winds in Germany are west and south, concessions for industrial establishments to the west and south of forest or cultivated lands should be granted only at considerable distances. In hilly regions the direction of the wind is to be more carefully considered than in flat regions.

1905


Gives brief notice of methods successfully followed by smoke inspector. (MIR—Bib.)


Briefly summarizes a few books and papers on the smoke problem that have appeared during the last 65 years. (MIR—Bib.)


The smoke problem is presented as being distinctly national rather than local in interest.

Some whose rights are violated by the smoke nuisance are women, merchants, clothing milliners, dressmakers, grocers, druggists, and jewelers, and others whose merchandise are damaged by smoke.

One city, however, cannot change conditions for fear that industry will be driven to some vital city. It is therefore important that cities cooperate in regulation of the evil.

The calling of a national antismoke convention, to include all organizations having either a direct or contingent interest in the solution of the problem is recommended.

The cooperation to be effective must be national in extent and must have distinct objects in view such as:

1. Development of an enlightened and quickened public sentiment on the subject.

2. Careful determination of all economic facts and an equitable adjustment of all conflicting interests involved in the controversy.

3. Determination and demonstration of all principles, practices, plans, and appliances for practical smoke prevention.
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4. Formulation of a standard law which, with modifications to meet local conditions, can be adopted by all cities and which will therefore result in virtually uniform regulation of the evil all over the country. 1996


This society was formed in 1896 to determine the nature and extent of atmospheric impurities arising from coal smoke; to consider coal consumption in boilers, furnaces, and domestic fireplaces; and to examine the present system for controlling the emission of smoke.

In calculating the amount of soot in the air of Leeds, it was found that about one-half ton falls on Leeds each day, as determined in January 1892. Use of gas and more stringent laws regulating regarding emission of smoke are suggested remedies.


This is a very interesting and detailed review of the report made by the St. Louis Civic League on its extensive smoke investigations.

The following points are discussed: (1) Agitation in St. Louis; (2) damage by smoke; (3) park trees killed by smoke gas; (4) consumers object; (5) simple remedies; (6) court decisions; (7) Baltimore’s ordinance; (8) Chicago’s difficulties; (9) Milwaukee’s regulation; (10) Chicago’s experience.


Review of a late study of the smoke problem by a committee of the Chamber of Commerce of Syracuse, N.Y. The following points are discussed: (1) Movement in various cities; (2) experience with various devices; (3) conditions of complete combustion; (4) devices for smoke prevention; (5) railroad smoke; (6) handling of devices; (7) economy from smoke abatement; (8) the committee’s recommendations.


Gives examples of the fight for 75 years against contamination of air by smelter smoke in England and Germany.

An animal disease brought the greatest danger to the Freiberg smelters, consisting of diarrhea, anemia, and atrophy of the bones, which existed in the neighborhood of Freiberg for 20 years.

As a rule, the deciding word was spoken by chemical analyses. In 1877–80 Von Schröder and Reuss made a careful study of the injury to pine trees from smoke in the Oberhartz. Von Schröder and Schertel made similar studies around Freiberg. If no abnormal content of sulfur, chlorine, or fluorine was found in the needles of the diseased trees, the injury was not due to smoke.

In 1855 Freiberg had to pay the first damages to the injured inhabitants; damages reached the maximum of 61,000 M. in 1864, 18,000 M. in 1870, and 3,000 to 4,000 M. per year thereafter. To 1893 a total of 580,000 M. had been paid for current injuries and 644,000 M. for permanent relief.

The trouble was considered to be due mostly to sulfuric acid, but hydrofluoric and hydrochloric acids are mentioned. The injury to animal and vegetable life in the vicinity of smelters led to the enactment of burdensome laws and regulations to prevent the emission of harmful gases.


In connection with the smoke question the evil effects arising from the acid gases, which are associated with all kinds of coal smoke, frequently are overlooked. The analysis of rainwater collected in the neighborhood of towns and its marked action on galvanized iron and other easily attacked metals, on exposed fabrics, and on building stones and mortar proves the prevalence and injurious effect of the acid impurities. Many analyses have shown that the surface of buildings and outside sculptures becomes converted into a crust of sulfates; the corrosion is accompanied by a roughening on which carbon settles, making the well-known black streaks or stains.

The detrimental action of urban fog on plants is due not so much to sulfur compounds as to the deficiency of light, the cold dampness and the deposit of tarry substances, soot, and dust. In a series of experiments on growing plants made in 1903 it was found that a proportion of pure diluted sulfuric acid gas many times greater than that present in a thick yellow fog was tolerated, the effect being only comparable to that of a change of a few degrees in temperature or of a moderate reduction of light.

From the results of a large number of analyses of the air of London, Manchester, and Liverpool, the Air Analyses Committee of Manchester, in conjunction with the Royal Horticultural Society, concluded that:

1. In clear, breezy weather the amount of sulfuric acid is less than 1 mg. (0.015 grain) per 100 feet of air.
2. In anticyclonic periods it rises very considerably, and in times of fog 34 to 50 mg. (0.51 to 0.77 grain) have been recorded for the worst districts of Manchester and London, respectively.
3. In an open space or a less densely populated area, there is a marked diminution in the amount of impurities in the air.
4. Increase in the amount of sulfuric acid is accompanied by at least as large an increase in the amount of organic impurities in the air.
5. Smoke, promoting the formation of fog and preventing diffusion into the upper stratum of the air, is the principal cause of the impure state of the atmosphere in large towns.


Smoke is defined as being composed of the volatilized products of the combustion of an organic substance, such as coal and wood, charged with fine particles of carbon.

The smoke problem has been a vital one for many centuries. Even as far back as 600 years, King Edward I made the use of sea coal punishable by death.

The economy resulting from smoke abatement is a potent argument in its favor.

The various activities that contribute to the nuisance and the right of every individual to have air free from all artificial impurities are discussed. The minor phases of smoke nuisance, as tobacco smoke, steam rising from sewer holes, auto smoke, and garbage and reduction-plant smoke and fumes, are described briefly.


The following subjects were discussed: (1) Work and policy of the Smoke Abatement League of Great Britain; (2) let there be light; (3) explanation of the Draft Parliamentary Bill; (4) draft of Smoke Prevention Act, 1912; (5) effects of coal smoke; (6) effects of smoke on vegetation; (7) relations of smog and health; (8) domestic smoke; (9) air pollution in...
Glasgow and other towns in Scotland; (10) effect of smoke on boiler-plant efficiency; (11) generation of smoke, economically and smokelessly.


Investigations show that the smokeless American city is entirely possible. It will come when the public conscience has thoroughly awakened to the enormous waste of natural and human resources through this evil.

Black, dust-laden smoke has been proved to be wasteful. It is economy to have smokeless mills, factories, and cities, and the converts this consideration is making daily to the reform bid fair to soon get rid of the spreading, insidious, heaven-obscuring nuisance.

1912


Although dwellers in a district where soft coal is burned almost universally condemn smoke and know in a general way its injurious effects, certain definite injuries resulting from smoke are not a matter of common information. Some of these injuries are discussed.

Some effects on buildings and building materials, metal, and vegetation are described. It is stated that the nature and composition of soot make it the worst possible kind of dirt. Soot is black; in fact, it is the lampblack that forms the basis of black paints. Its power of absorption is great, giving it the property of occulting large quantities of injurious gases. The contained tar gives the soot the power to adhere firmly to anything with which it comes in contact, while the contained sulfur acids corrode most substances. A more objectionable kind of dirt would be hard to find.


Improved conditions at plant of Fleischmann Co., Riverside (Cincinnati), are mentioned; no technical data. (MIR—Bib.)


In 1911 a Pittsburgh businessman donated a fund to the director of the Department of Industrial Research of the University of Pittsburgh, for making an investigation of the smoke nuisance, with particular reference to Pittsburgh.

The investigation was conducted by a staff of specialists and was divided roughly into two parts—the analytical or diagnostic and the constructive or remedial.

In addition, provision was made for a brief history of the smoke nuisance in both Europe and the United States and for an exhaustive bibliography.

1913


Paper presented at organization of Smoke Abatement League in Pittsburgh by the chief mechanical engineer, Bureau of Mines. (MIR—Bib.)


Notes on abatement campaign in Memphis, Tenn. (MIR—Bib.)


Excerpt from advance copy of smoke-abatement section of annual report of the Minneapolis Civic and Commerce Association for 1912. Year's work includes over 775 inspections, from 385 of which records were obtained; receipt of 97 letters of complaint; sending of 121 letters to violators; 21 cases of arrest, with imposition of fine in each case. (MIR—Bib.)


This exhaustive bibliography of the literature concerning smoke and smoke prevention is a useful guide for before 1913. (USPHS)

33. RUTHERFORD, PAYNE. Louisville Department Finds a Need for a Smoke Consumer for Low-Pressure Boilers. Ind. World, vol. 92, 1913, p. 141.

Brief notes and statistics by city smoke inspector of Louisville, Ky. (MIR—Bib.)


Brief statistics for fiscal year ending March 31, 1912, by chief smoke inspector, Grand Rapids, Mich. (MIR—Bib.)


Statistical summary of year's work by city smoke inspector. (MIR—Bib.)

1914


As a result of the Smoke Abatement Conference held in London in 1912 and at the instigation of the permanent Committee for the Investigation of Atmospheric Pollution, regular and systematic observations of sootfall were begun October 1, 1913, in the various London boroughs and 12 other important towns and cities in Great Britain with the standard instruments devised by the committee. Bailie W. B. Smith, who has charge of this work in Glasgow, recently visited the United States and endeavored to interest the municipal authorities at various places in this country to undertake similar observations.

1915


The impurities of air are discussed in a general way. The overall problem is considered of grave enough consequence that action or lack of action may mean the difference between health and disease. Gaseous compounds emitted from furnaces are considered to be "poisonous" and to render the air incapable of carrying the normal amount of oxygen. (USPHS)

1916


Some of the important statistics that show the trend of the times, the shaping of public opinion in its attitude toward the smoke-abatement problem, and what a serious portion of this problem comes from the apparently harmless heating fires of the average American homes are pointed out. Taken collectively, however, this part of the smoke problem assumes very serious proportions and offers a great field for work in reducing the amount of smoke and tarry substances in the air.

The important developments that have taken place since the invention of the furnace, in the effort to
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solved the problem of smokeless burning, from the time of Watt up to the highly efficient and perfect combustion boilers of the present time are reviewed. This historical review gives much information to guide present-day combustion engineers.

There is still much to be done in educating the American citizen or the man who takes care of his boiler in the art of firing, so as to obtain maximum efficiency together with smokeless burning. The great need for better attention to firing in large buildings in which the new type of downdraft boilers is installed is being recognized and a distinct improvement in the class of heating that has been noted. The solution of the smoke problem, as regards heating boilers, lies, first, in the education of the fireman to know how and when to fire and in adoption of the smokeless downdraft boilers for large heating installations.

Some day it is hoped a smokeless burning boiler of small size capacity may be introduced for residences, but in the meantime improvement must be looked for in the smoke situation from heating plants by continual pounding away at better methods of firing, and bringing the seriousness of the smoke situation repeatedly to the attention of the public.

1920

39. Smoke Abatement Investigation. Repit. of Cooperative Smoke Abatement Investigation, Salt Lake City, Utah, University of Utah, Bureau of Mines, June 1, 1920, 10 parts.
The points discussed are: Scope and purpose of investigation; location and weather conditions; fuel surveys; smoke readings; determination of atmospheric impurities; industrial and large heating plants; locomotive; residences; story of Salt Lake smoke formation; recommendations.

1922

Defines smoke problem and discusses causes of smoke.

The general aspects and important features of an investigation of smoke abatement and fuel technology in the principal localities of Great Britain are described.

The principal interesting factors in smoke control in England discussed are legal control, measurement of atmospheric pollution, education of firemen, publicity and public education, smoke-consuming appliances, low-temperature carbonization of coal, electrification, coal-dust firing, coal flotation, and increase in the use of gas. (90 refs. cited)

1923

Calls attention to the need for civic interest in smoke abatement. Discusses effects of atmospheric pollution upon health, vegetation, and property and gives results of experiments.

1925

Reviews a chapter of the book, Smoke, a Study of Town Air. It deals with impurities in the air in various parts of London and other places in England, caused by coal and transformed into sulfur dioxide ($SO_2$) and then into sulfuric acids. Sulfur compounds from burning coal, soot containing acids, sulfur and chlorine compounds in rain, and figures of sulfur and acidity in amounts of $SO_2$ and $SO_3$ are cited. An air-washing apparatus is also explained. Definite conclusion is that free sulfur acid exists everywhere and is harmful, not only to human life, but to masonry and vegetation.

45. —. Smoke, a Study of Town Air, London, 1925.
Soot consists of carbon, tar, ash, sulfur, arsenic, and nitrogen compounds. Lists several charts on the analyses of soot. Shows adherence of soot to buildings in photographs. Explains effect of soot on vegetation. The gaseous impurities, sulfur acids with vegetation, damage masonry, and corrode metal. Each of the other gases is discussed separately. Without dust there would be no fog, mist, rain, or dew. The formation of fog and pollinants are discussed. Photographs demonstrate the effects of soot and smoke on vegetation in different areas. Tables indicate that the greater the smoke concentration, the higher is the death rate. (USPHS)

1926

The following advantages of gas coke as a domestic fuel are discussed: (1) The consumer is paying for fuel value only and not for quantities of ash and slate; (2) he has a fuel that is easily handled owing to its light weight; (3) gas coke is a fuel that does not require a long time to heat; (4) dangers from roof fires are eliminated; (5) no dust or soot is deposited on the surrounding neighborhood; (6) the cost of redecorating and cleaning is greatly reduced; (7) the health of children, to whom the greatest care is owed, is not impaired.

This book, which is devoted to the problems of smoke in large cities, discusses meteorological aspects, nature and origin of smoke, industrial uses of smoke, economic aspects, measurement of atmospheric pollution, numbers and kinds of polluting particles, and methods for smoke abatement. Some sections are devoted briefly to the health aspects of smoke. The loss of sunlight is especially discussed. (USPHS)

1926

It is interesting to see among the names of the distinguished members of this advisory committee those of some who have recently contributed to our knowledge by articles. W. B. Smith, for example, has brought to general notice the Macfarlin method of carbonization of coal, which is so great a success at Glasgow, while the recall with gratitude the lucid quality of Dr. Margaret Fishenden's summary at Birmingham last September of the outlook for smokeless domestic heating. In such an alliance between the American citizen or the man who takes in the quiet of the laboratory and those in the hustle of the business world is to be found the promise of much progress.

Considerable practical importance attaches to Dr. Owers' showing that presence of hygroscopic salts in air induces fog at humidities much below saturation point.
When it has been put into a little better shape, the chart, showing how the amount of ultraviolet rays recorded at ground level diminishes as the amount of matter suspended in air increases, will be very useful for propaganda purposes.

Dr. Ashworth's "daily deposit recorder" has proved so useful that it may be briefly described as a disk rotated by clockwork at one revolution per day, bearing a sheet of moisture filter paper upon which fall the dust particles through a vertical cylinder placed over a small part of the area of the disk. With this means of counting the deposited particles precisely at leisure and for no more than the records for permanent reference, precision has been given to older methods of observation while new ones have been initiated. Comment may be reserved until publication of the fuller data promised by various conclusions can be considered fully established, and the curiously complex relationship between rainfall and deposition of solid particles from air will receive the detailed study which it demands.

(In view of the enormous mass of observations recorded, it would surely be worth while adding a brief summary of the general conclusions drawn of gases whose duty it is to study these results. The average reader might spend a lifetime finding what to look for in this maze of figures.) (BH)


The antiquity of the air-pollution problem is indicated by the belief of the ancients regarding the active role of wandering particles in the air in the development of disease, especially fevers. Undoubtedly this is the origin of the "miasmatic" theory. The great fires that were lighted at the entrance and exit of cities had for its object burning these miasmata carried by the atmosphere to establish a virtual barrage to prevent their propagation.

A limited discussion, as brief as possible, is presented of the origin of the fumes and dusts issuing from the combustion of coal, causes of their harmfulness, the scientific methods for control of the purity of the air, and, finally, the exact means to limit the production of these nuisances.

It is suggested that some philanthropist or financier create in industrial cities large centers to distribute fresh, pure air from the country as water is distributed, for the renewal at night of the air of rooms where a little, more of half of our existence is spent.


Conclusions of the Chicago Association of Commerce, through its committee of investigation on smoke abatement, on effects of atmospheric pollution were as follows:

There is a general agreement among sanitary authorities that polluted air is harmful to health. At present there is no accurate method of measuring this harm or of determining the relative responsibility of the different elements that enter into the mixture of gases and solids commonly referred to as atmospheric air.

The direct effect of smoke or any of its attributes, including soot, dust, and gases, in amounts that may ordinarily pervade the atmosphere of a smoky city, is not shown to be detrimental to persons in normal health.

The direct effect of smoke upon those who are ill has been most extensively studied in connection with tuberculosis and pneumonia. It appears that smoke does not in any way stimulate the onset of tubercular processes nor militate against the rapidity of recovery when once this disease has been contracted. In cases of pneumonia, the effect becomes seriously detrimental. In addition to these direct effects, indirect effects result from the diminution of sunlight and the increase in fogs, clouds, and haze.

The general physical tone is lowered as the result of long-continued breathing of polluted air.

In summary it was concluded that smoke excited injurious effects on vegetation directly via poisonous gases or indirectly as result of fogs. Effects are not specific, and the amount of smoke necessary to produce damage was nondeterminable. (USPHS)

1927


Reference is made to the remarkable study made by Dr. Bordas on the smokes and dusts in the atmosphere of large cities, published in 1926. Attention is called to the very lively campaign in the press for the suppression of fumes which annoy the residents of large centers and their environments.

The scientists having demonstrated the harmful effects of the smoke, the legislature was led to prohibit it on the condition that there were available commercially apparatus that would suppress smoke from industrial plants. The English laws were discussed briefly and the application of the French law of 1917 relative to dangerous and unhealthy establishments is described.


The idea of grouping in an article some notes collected on industrial fumes was suggested by the announcement in the press of a competition to determine the most efficacious measures for suppression of industrial smoke.

Reference is made to conditions in Paris sometimes almost comparable to a London fog. The effects of the gases on old monuments and buildings are discussed. Smoke conditions in England and Germany are reviewed and the conditions, laws, and regulations for suppression of smoke in these countries are discussed. The first regulation on smoke in England appeared in 1845.


Atmospheric pollution is not only a nuisance but also a source of danger to numerous living organisms, including human beings, and a serious menace to the permanence of a great variety of materials. The difficulty in raising public opinion to action in smoke abatement is cited.

1. Physical and chemical deterioration caused by smoke necessitates extra cost of cleaning and washing materials, such as clothes, carpets, paintings, and walls of buildings, soiled by soot and tar; and an increased need for artificial lighting. The smoke's corrosive action on metals is also costly.

2. Damage to vegetation is caused by the clogging of pores and the destructive action of sulfuric acid, now considered, by far, the principal cause of damage. The sulfuric acid in sootfall acidifies the soil and renders it nonproductive for many types of vegetation.

3. Seriousness of the effect of sulfuric acid and estimates of the amount of sulfuric acid deposited annually in St. Louis are discussed.

4. The harmful effects of smoke on health have not been proved on a clear, scientific basis. The statistics reported by various authors showing a correlation of smoky days with increasing incidence of respiratory disease and deaths are not considered to be scientific proof of cause and effect.
5. Smoke and pneumonia: Smoke is considered of minor importance, but nonetheless a factor in the incidence of these woe-deeds; however, in sequenices it is cited of a series of dense smogs in Glasgow in 1909 compared with contemporaneous conditions in seven neighboring towns. The other towns were not nearly as smoky, and the death rate following each smog in Glasgow was as much as twice the rate of the other seven towns.


The examination of atmospheric impurities is discussed thus:

(a) The ratio of domestic to factory soot can be determined by the proportion of tar. This forms 25 percent of domestic soot but only 1 percent of factory soot. The proportions of each can thus be calculated from the ascertained percentage of tar in the deposited soot.

(b) The cost of smoke per head per year is given as ranging from 17s. at Stoke-on-Trent to £3 15s. at Burnley, while the average weight of soot deposited annually in London in recent years is stated to be some 200 tons per square mile, rising to 476 tons at the center of the city.

(c) Location of factories in relation to residential areas may have to be reconsidered in view of the discovery that it is winds of under 1 meter per second velocity which are associated with smoke-fogs that vigorously disperse.

(d) There is a most interesting account of physical laws ingeniously applied in the "dust counter" he has invented to estimate the minute suspended particles that settle— if at all—too slowly to permit of gravity being used for their estimation. The air is saturated with moisture; on being blown forcibly through a chamber via a small hole, the jet is cooled by the resultant expansion of air so that the moisture damps the suspended particles by condensing upon them; the jet being then made to impinge upon a glass slide, more moisture condenses upon the cold surface of the slide to which the damp particles thus adhere.

In this way it was found that these particles range from 5,000 per cc. in London air, as a winter average, to 80,000 per cc. in a dense smoke fog.

As regards heating, a very strong point is made of the fact that a living-room fire in a house to promote comfort, the production of heat being but one factor and hence not to which upon which to base exclusively the standard of efficiency of a grate.

A very strong demand is made for revision of obsolete standards of fresh-air needs and the absurdity is pointed out with which air is doled out under present standards in minimal amounts as if it were scarce and rationed. Abandonment of the ancient CO standard is urged in favor of a standard based upon the reduction of concentration of infectivity by removal of solid particles (including, of course, the infective bacteria). This can only be secured by the freest possible currents of air between the vitiated atmosphere of occupied rooms and the open air outside. (EH)


"Dust twisters," as they are called locally, often grow to such proportions in the dry plains of the West that they resemble tornadoes, although they are merely big brothers of the familiar whirl winds seen in the East on hot, dusty days. Sometimes half a dozen of these giant whirls are in sight at the same time in the western plains country, giving an appearance at a distance of waterspouts at sea. These twisters throw sand dirt in every direction. At the time, 12:30 p.m., one of these was observed in Kansas the temperature of the air was near 100° and the sky was entirely clear.

56. WICKERSHEIMER, E RNEST. Fumées Industrielles de establishments insulubres à Rouen en 1510. [Industrial Fumes and Unhealthy Establishments in Rouen in 1510.]

Mentions the emotion aroused among the people of London and vicinity when in 1288 the time burners conceived the idea of substituting coal for the wood and charcoal formerly used in their furnaces. At one time the king of England notified all artisans that he would expose them to severe punishment if they persisted in using such a malodorant.

Chased from London by the fumes, William III changed his residence to Kensington in 1690. In the struggle between the crown and coal the latter won out in the end.

Boats ascending the Seine brought coal to the port of Rouen; however, at Rouen for a long time coal was used only in the homes.

The 16th century was opening when they began to use it in industry. Then, as on the east in the time of Edward I, there was a great outcry, and some of the users of coal were prosecuted before the President of the Exchequer. A commission was appointed whose report expressed two opposing opinions. One, that the industries using coal be remote from the city, the other, that it would be sufficient to exhaust the chimneys.

More than 40 witnesses were heard, some of them doctors. The latter were against the use of coal on account of the evil and dangerous smells it caused.

1928


For 80 stations in Great Britain this report records the following deposits, in metric tons per 100 km. per annum:

(a) Insoluble matter, as (1) Tar; (2) other carbonaceous matter; (3) ash. (b) Soluble matter, as: (1) Volatile and (2) ash. (c) Total solid matter. (d) SO₂, Cl₂, NH₃—included in the soluble matter.

These stations are, further, graded into four classes, according to the amounts of recorded deposits. This affords a valuable means of rapid, nontechnical comparison of a town's atmospheric pollution, month by month, with its previous standard and with the standards attained in other towns. Such a basis of comparison forms a very useful means of stimulating local authorities. The comparison between the excellent records of Birmingham (Bournville) and those of one of England's most celebrated seaside resorts on the south coast might well serve to initiate action by the town council of the latter and illustrates strikingly the part played by the domestic grate in polluting the air. The more such observations are made, and given wide publicity, the better; towns persistently graded D, while their neighbors were in grade B, might eventually be graded into remedial action.

There follow some results obtained with the automatic filter, showing hourly variations in amount of deposit. But nothing striking or new emerges from comparison of hourly or diurnal variations.

Some observations with "jet dust counter" are given, the most interesting being that a dense summer haze at the sea coast was found to consist almost wholly of crystalline salts—presumably those of sea water.

Most important is a graph showing the obstruction of the great proportion of U-V rays by even slight smoke.
Sootfall on Newcastle quayside amounts to 1,000 tons per square mile p. a. Newcastle sunshine is at least 33 percent, and often 50 percent, less than at Morpeth, a few miles north. Newcastle death rate for pneumonia and bronchitis rose by 70 percent (over the average) after the abnormal succession of fogs in 1923. Manchester spends £250,000 and 6,000,000 hours p. a. on its laundry more than it would were it no smokier than Harrogate. On every foggy day it spends £2,000 on extra electric light alone.

Glasgow has halved its sootfall in the last dozen years and now forbids discharge of smoke from industrial flues for more than 1 minute in every half-hour. By its Macaulay method of low-temperature carbonization of coal it produces—in addition to gas and 20 gallons of crude oil per ton of coal used—a “Kineole” coke at 45c. a ton, which has a higher calorific value than an equal weight of coal, and burns readily with out smoke.

In view of these striking facts, it is recommended that
(a) Regional smoke abatement committees be formed to:
   (1) Stir public opinion by propaganda;
   (2) assist works managers by expert advice re smoke prevention;
   (3) organize classes to instruct firemen in the art of stoking well.
(b) Inspectors be employed with expert knowledge of smoke prevention and sanitary inspectors be induced to obtain the Smoke Certificate of the Royal Sanitary Institute. (BH)


Reviews work of the Mellon Institute smoke investigation of 1913, including additional later observations and data to indicate results of studies since 1913. Discussed are meteorological aspects; effects on stone, metals, outside painting, and interior of buildings; effects on vegetation, influence on health; and economic cost. (USPHS) 1929

60. JOURNAL, AMERICAN MEDICAL ASSOCIATION. Atmospheric Pollution From Power Stations, Vol. 92, 1929, p. 1875 (foreign letters).

Objections were raised to the site of power station to be built in London, England, at Battersea because of sulfurous fumes, which are injurious not only to important buildings, but also to many public and private gardens and open spaces in London. It is suggested that another site be obtained that is not open to this objection.


The smoke problem is no new trouble; complaint about the smoke nuisance was made to Edward I in 1288, and he ordered his officers, in conjunction with the city sheriffs, to seek a remedy. Further complaint was made in 1307, and sea coal was especially impugned, severe penalties being enacted for its use! In 1390 William III gave up the contest and retired to Kensington.

Of recent years the amount of deposit has tended to diminish somewhat both in London and Glasgow. It is a mistake to attribute the problem entirely or mainly to industrial pollution. Domestic fireplaces, establishments with central heating, restaurants, locomotives, and steamships all add their quota.

Rain tends to diminish the total amount of deposit, increasing the soluble but decreasing to a greater extent the insoluble deposit.

In the smoke fogs of London the particles of soot replace, to some extent, the water droplets of rural or sea fogs. The slightly higher temperature over towns in still weather would render the air over the towns heavier from fog than that over the surrounding country, were it not for these suspended particles of soot. Ascher is said to have exposed rabbits to moderate quantities of smoke for some weeks and then to have made them breathe microscopic sprays. Those so exposed developed pneumonia, while controls that had not been exposed to smoke escaped. Exposure of rabbits to SO2 accelerated progress of tuberculosis.

Soot is stated to contain 4 percent of sulfurous acid. This substance is regarded as dangerous, apart from soot, alike to men and plants. Several French ordinances against smoke pollution are quoted in full. These do not appear to contain any valuable preventive powers not contained in the corresponding English legislation. (BH)


Generalized statements are made on the control of air contaminants, and sootfall tables for various towns of Great Britain are given. Domestic fires are considered the chief source of contaminants. (USPHS) 1930


Points of view of the industrialist and scientist with regard to matters concerning atmospheric pollution by smoke are discussed. Present laws governing smoke abatement are discussed with particular emphasis on their inadequacy. The general theme is that abolition of smoke is necessary not only from the health aspect but also from the various economic aspects.

It is considered indisputable that smoke in the atmosphere contributes to the incidence of rickets, tuberculosis, anemia, and wasting and crippling diseases of childhood.

The greater use of low-temperature coke by the domestic user is encouraged. (USPHS)


The smoke-abatement activities of Indianapolis are summarized and future plans are presented.


Five major phases of the problem of air pollution are discussed under the headings of public health aspects, economic aspects, present knowledge, present needs, and administration, with recommendations in conclusion. (6 refs. cited) 1931


Collection stations throughout Cleveland revealed 23 percent carbon and 77 percent ash, of which 30 percent was ferric oxide. Not collected were gaseous elements as carbon monoxide, carbon dioxide, ammonia, chloride, nitrous acid, nitric acid, sulfur dioxide, sulfur trioxide, sulfuric acid, hydrogen sulfide, all of which have detrimental aspects such as corrosion of metals and pathological effects on plants and animals. The sources for these contaminants are discussed. Recommendations are made for the amelioration of those pollution factors. (USPHS)


The remarks of Dr. H. A. Des Voeux, president of the National Smoke Abatement Society (London), are discussed. He said that excessive smoke was not a necessity but a luxury of laziness, and should not be allowed by authorities charged with the protection of the health of the people.
1932


The term “smoke” as it is applied indiscriminately to all visible solids arising from stacks is discussed. There are two photographs of “smoke” both of which was the same magnification that show they are totally different in grain size, appearance, and nature. One shows true smoke and the other stack dust.

1933


A report on atmospheric pollution, issued by Department of Scientific and Industrial Research.


The theory of the role of fluorine compounds as the principal agent in the Meuse disaster is explained as untenable. (1) The accused factory from which hydrofluoric acid was supposed to have been released was running at less than one-fourth normal activity at the time. (2) Only a small part of the fluoride in the new materials was released. (3) Wind, although almost nil, was blowing in a direction from Liege toward Huy, and this plant producing hydrogen fluoride is down wind from the disaster area. (4) As this plant was the only source of hydrogen fluoride in the valley, the appearance of symptoms should have occurred first near the plant, whereas actually symptoms appeared simultaneously over a wide area. (5) The amount of sulfur released was much greater than that of fluoride. (USPHS)


Written for the lay reader, this résumé of the air-pollution problem includes a discussion of control of combustion, physiologic and economic effects of pollution, and regulatory recommendations. Possible dangers to health, as well as less tangible results difficult of proof, are broadly covered. (USPHS)


Tests were conducted under the sanction of the Mellon Institute of Pittsburgh, Pa., which will use the findings in its studies of air hygiene.

Visible smoke nuisance was not examined in the recent tests at the Anthracite Institute laboratory, nor was the health factor considered. Fourteen individual tests were made by the Anthracite Institute laboratory under identical conditions, with commonly used sizes or grades of Pennsylvania anthracite, coke, bituminous coal, and furnace oil. In each instance a 100-mesh screen was introduced in the stack for 1 hour, after combustion had been brought to peak efficiency under observation of engineering representative of the several fuels. Comparisons were made of the deposits adhering to the smoke.

For purposes of comparison, Chestnut-size anthracite was defined as unity from which relative stack output was computed as to volume, weight, density, and soiling or staining characteristics.


Smoke-abatement problems during 1932 were not as prominent as in years of greater industrial activity. This is equally true of the entire pure-air question. Not that there is less understanding or interest in the prevention of air pollution, but simply that there has not been the usual manifestation of the nuisance.

1934


Discusses all aspects of supplying clear air, including theories of air conditioning in plants and homes. Enumerates effects of atmospheric contaminants, such as on health, aviation, buildings, and vegetation. Mentions the Meuse Valley disaster and higher pneumonia rates in urban communities. Gives recommendations for improvement. (USPHS)


The general aspects of air pollution, its extent, cost, and need for abatement, are emphasized. The bacteria-carrying capacity of smoke, or dusty air, as well as the irritative effects of the products of combustion on the nose, throat, sinuses, eyes, ears, respiratory tract, bronchial tubes, and gastrointestinal area is discussed. There is a striking parallel between smokeiness of cities and a higher pneumonia rate. Cleaning the air of the United States might do as much to reduce the incidence of pneumonia as cleaning the water did to reduce typhoid. Recommendations are made for improvement in ordinances covering smoke abatement. (USPHS)


The contention is supported that air pollution can be eliminated, and suggestions and recommendations as to how this may be accomplished are presented. Discusses needs for clean air, the nature of air pollution (contaminants) and suggestions for the studies and work that have been done, particularly at the Mellon Institute, as well as effects of smoke: Destruction of building stones, metals, paints, clothes, and decorations, retardation of the growth of vegetation; formation and prolongation of fogs, certain pathological effects due to inhalation of solid particles and decreased sunshine. Medical specialists state that inspired airborne impurities irritate the sensitive membranes of the eyes, nose, throat, and lungs, and thus aggravate or cause various maladies of those organs, or increase their susceptibility to acute diseases of the respiratory tract. These pollutants also enter the gastrointestinal tract and may induce systemic poisoning. (USPHS)


The source and general problem of polluted air are discussed. The effects of pollution on meteorological conditions depend on size of city, rate of production of impurities, and the rate at which wind and convection currents can carry the impurities away. Fogs form more quickly, reach a greater density, and be prolonged in the presence of smoke. Studies in Baltimore and New York indicate one-sixth less sunshine, on the average, in those cities in contrast to outlying areas.

Smoke, dust, and gases are detrimental to growth and to fruit-bearing vegetation. This is evidenced by external and internal appearance and by yield.

The psychological and hygienic aspects of air pollution are considered closely allied. A smoggy atmosphere irritates the mind as well as the respiratory tract. There is often a feeling of depression translated into nervousness. The effects on the body range from mild irritation to a serious or even a fatal event. None of the solid or gaseous products of combustion can be said to be wholly harmless in relation to human health. (USPHS)

1935


One of the most interesting scientific and educational exhibit at Century of Progress Exposition in Chicago
is described. This smoke-abatement exhibit was offered to the public through the Department of Smoke Inspection of the city of Chicago and was made possible by the financial aid of the cooperative efforts of Chicago's industries, coal-producing operatives, and equipment manufacturers.


Those who are inquiring into the factors that will solve the house smoke nuisance are noting with satisfaction a record increase in the installation of stokers in the soft-coal areas west of the Alleghenies. Apart from its automatic features, the stoker has the virtue of feeding the fuel gradually and uniformly supplying necessary air. Better combustion results.

Parents are keenly sensible of the probable damage being done to their children by smoke and dust. This leads to the belief that, as hard times are lifted, a great deal of individual effort will be made toward remediating domestic sources of atmospheric contamination. The influence of smoke on housing conditions and the influence of housing conditions on physical and mental development of children are too well established to need discussion.

It does not take a scientist to tell that the average parent that a child living in a smoke-deteriorated section of the city is under a handicap compared to the child residing in urban sections which are free of offensive smoke deposits. Bad housing and bad air seem to be companions, so closely do they keep company. Smoke is the greatest of all the causes of dirt and darkness in cities. It supplies something to each of the four deadly "D's"—dirt, darkness, disease, death. These are the foes of children which parents know lurk in city smoke walls. The responsibility for these winter smoke blankets today rests as much on the private dwellings as on all other sources combined. The widespread realization of this fact will in itself assist in restoring to urban children the weakened sunshine and hygienically safe air nature intended for them.


The effects of smoke, grit, and acids on health, loss of daylight, and damage to buildings and vegetation are considered.

It is estimated that about 1,000 tons of sulfuric acid are liberated in the atmosphere of London every day.

The statement is made that the number of deaths from pulmonary and cardiac diseases increases in direct proportion to increased intensity and duration of smoke fogs. In and near a great industrial town, under present conditions of life, there are no ultraviolet rays.

The estimated annual bill for smoke in the United States is said to be 500 million dollars, of which 140 million dollars represents the cost of spoiled merchandise and the cleaning of buildings.


The constituents of smoke, its causes, its effects upon health, smokeless fuel, and three main systems employed for low-temperature carbonization are discussed. Also a standard gage for the measurement of atmosphere pollution and an apparatus for procuring pictorial records are described.

Suggestions are made for the reduction of smoke. Instructions are given that should be carried out by stokers. A drawing illustrates the chief sources of loss of heat in steam rising.


1936


The seventy-second report of Allhall, etc., by the chief inspectors to the Minister of Health, is reviewed. Reference is made to atmospheric pollution by various industrial plants.


Points stressed in this statement regarding smoke control in the District of Columbia were imperfect combustion and waste of fuel, extra expense of cleaning clothes, disfigurement of buildings, injuries to plant life, loss of daylight, and injuries to health. (USPHS)


Part I. Origin and nature of the study: The aim of the study was to determine the average conditions of the air in large American cities and to obtain information of value in planning future programs for smoke abatement. Fourteen of the largest cities of the United States were selected. Washington, D. C., was used as a control city because of its unusually slight air pollution. Details of previous studies are given.

Part II. Describes instruments, technique, and records.

Part III. Discusses general level of atmospheric pollution: This has been limited to the winter months to concentrate attention on a period when atmospheric pollution would be expected to be the greatest. This study is based on suspended impurities; former analyses were based on settled dust. Data are given for the average results of the study for all the cities for the winter months. The 14 cities are divided into three groups, according to extent of pollution.

Part IV. Composition and particle size of suspended and settled dust are considered.

Part V. Attention is paid to seasonal and diurnal variation in atmospheric pollution: Atmospheric pollution was found to vary widely with the season, reaching a maximum in the winter and a minimum in the summer. Findings were based on the amounts of contaminants caught by automatic air filters. During the coldest part of winter, air pollution was about twice as great as in midsummer. As for the constituents, carbon is in greatest concentration in the winter, whereas ash is greater in the summer, and silica does not vary much with the season. (USPHS)


An interesting discussion of the smoke nuisance is presented from the sanitary inspector's point of view. The complaint is made that manufacturers, steam engineers, and stokers, particularly those whose steam-raising plants are small, are not interested enough in smoke abatement, and do not take adequate measures to prevent nuisance.

Steam and water gages must be fitted in all boiler plants, but appliances for recording furnace temperature, draft, and the concentrations of carbon monoxide and carbon dioxide in flue gases are usually absent. If these were fitted and used intelligently better combustion would be obtained, and smoke largely avoided. It can be argued that where the plant is causing a nuisance, and proper instruments are not installed, the best practical measures to prevent a nuisance are not being taken, and consequently an offense is committed against the Public Health (Smoke Abatement) Act, 1926.
The abatement of domestic smoke is discussed. If low-temperature-carbonization fuel ("Coalite") were reduced in price, and the public encouraged to use it, a big step forward would be made toward minimizing the domestic smoke evil. (BH)


Smoke causes economic losses (soils merchandise in stores, necessitates more frequent dry cleaning of clothes and repairing and repainting of buildings, injures vegetation (grass, shrubs, and trees), and exerts a possibly harmful influence on health through the loss of daylight and ultraviolet light. (USPHS)

1937


All questions of air impurities are taken up in detail. The physical basis for atmospheric pollution, such as the causes and kinds of impurities, the products of combustion, and industrial contaminants, is considered. Describes effects of these impurities on man, as well as on plants, metals, and stone.

One chapter is devoted to a description of the Meuse Valley disaster of December 1930. In this disaster 64 persons died, and 1,000 were taken ill. The conclusion was reached that the cause was one of a peculiar meteorological situation plus sulfuric acid formed from sulfuric acids originating from the many industrial plants. Sulfuric acid was named as the chief cause for deaths and illness. Hydroscopic acid from one plant was considered only a secondary factor. (USPHS)


Three kinds of materials comprise the bulk of smoke: Carbonaceous matter (carbon, soot, and tar), ash (mineral matter), and sulfurous gases. Smoke is suspected of causing high death rates of pneumonia and influenza, of complicity in sinusitis, conjunctivitis, anemia, rickets, and cancer of the lungs, of decreasing the available ultraviolet light, of creating a psychological depression, and of "rotting" (corroding) buildings.

According to some reports, nine-tenths of the smoke stays indefinitely in suspension; the heavier particles settle out over the community, depending upon the wind direction and weather. The Public Health Service found that the peak of pollution came in the winter; that the degree of pollution varied with temperature and time of day and inversely with wind velocity; that the cleaning effects of the rain are surprisingly small, and that wind, wind direction, and topography are vastly influential.

It is suspected that the greater share of smoke in the wintertime is from either domestic sources or small, one-boiler factories, rather than from large plants. Smoke-pollution damage runs into the millions of dollars in large cities.

To correct the vast amount of smoke put out into the air daily, these suggestions are made: (1) Wash the coal before firing and eliminate 25-50 percent of the sulfur as well as some of the ash; (2) remove 95 percent of the solid content of smoke by smoke reducers, of which the Cotrell electrostatic precipitator is best; (3) utilize and burn the coal more efficiently. (USPHS)


The effects of high sulfuric contents of coal, both raw and processed as pulverized coal or coke, are mentioned and it is pointed out that it generally is more economical to pay for coal of low sulfur content. Troubles encountered are: Clinkering of grates, slagging of the walls, corrosion of all metal parts, pollution of the atmosphere, and danger of spontaneous combustion.


Mention is made of the work done in connection with ventilation, odors, and air conditioning, as related to solid contaminants in the atmosphere. A few of the other activities which the laboratory might be called on to investigate, such as noise, light, and special physiological methods, are discussed from the standpoint of some of the most recent work in these fields.


Urbanization and industrialization have created a grave problem of atmospheric pollution with which a smoke-abatement movement has tried to grapple.


It is well recognized that exposure to polluted air, especially certain fumes and dusts, for a substantial length of time is detrimental to health and human efficiency. We inhale 313/4 pounds of air daily; therefore, anything we inhale may be detrimental to our health. The air-pollution problem is closely connected with the problem of fuel economy. Facts show that air pollution of cities is due to the inefficient combustion of domestic furnaces. A set of figures compares the composition of soot from the top of a domestic chimney, the chief cause of air pollution, with that from the top of a factory chimney. (USPHS)


In this extensive monograph on fluorine intoxication, parts of various sections are devoted to fluorides as air pollutants. An extensive bibliography is included, as well as observations to show that air pollution by fluorides emanates from certain types of industrial processes and that such fluorides cause disease in man and animals, as well as serious damage to vegetation. (USPHS)


One phase of the New York pollution survey, a project of the United States Works Progress Administration for the study of New York, is presented.

After a few preliminary remarks regarding the general scope of the work, a complete discussion of the fuel utilization in New York City is presented. In 1933 New York City used about 31 1/2 percent of the total energy consumed in the United States. The type and distribution of fuel used are described in some detail. 1938


The interest of the coal industry in smoke abatement is discussed. It is stated that the coal industry is spending this year approximately $50,000 in an educational campaign in the architectural and building magazines and technical journals to show architects and builders what it means to them to specify to their clients the proper type, kind, and size of equipment.


The importance of the work of the Smoke Prevention Association of America to the Heating, Piping and Air Conditioning Contractors National Association is
stressed. The mutuality of interest between the two groups is emphasized. The latter association has made a valuable contribution to the work of the Smoke Prevention Association through the publication at regular intervals of its New Load Recommendations for Heating Boilers. Six phases of the work of the Smoke Prevention Association are listed as being of real importance to the work of the Heating, Piping and Air Conditioning Contractors National Association.


English editorial comments on air pollution and smoke abatement in America.


The results are given of 15-month survey to determine the average amounts of sulfur gases in the air of American cities, as announced by Air Hygiene Foundation and Mellon Institute. The average amounts of sulfur fumes found in 25 cities are comparatively small.

100. MARSH, ARNOLD. Engineering, vol. 147 (London), 1938.

Editorial referring to the leading causes of excessive smoke.


The findings are based on original experimental data in addition to writings and experimental data of others. Conclusions capable of practical application are presented.

1939


The results are given of a recent survey by the Chicago Smoke Inspection Department and the Engineering Experiment Station of the University of Illinois.


Any departure from normal air may be regarded as evidence of pollution. This may take the form of any abnormal concentration of gas, mist, solid, or even radium emanations. It may be harmful to plant and animal life, it may be a nuisance, it may form explosive mixtures with air, or it may be detrimental to machinery or manufacturing processes. Such pollution is usually the product of man’s activities but may be, as in the case of fogs and dust storms, of natural origin. Those of human production are in the main preventable; the control of those of climatic nature are in the experimental stage. The solution of many pollution problems has been speeded because of economic recoveries of valuable materials, but too often it requires the threat of damage suits to initiate change. The various types of contaminants and the methods of determining and controlling them are discussed. (JIHT)


In his History of Stones, published about 371 B. C., Theophrastus, a pupil of Aristotle, said regarding the burning of fossil substance called coals that they were of long continuance, but their smell was troublesome and disagreeable.

Complaints of air pollution by coal smoke began with the use of coal as a fuel in England. In 1257 Queen Eleanor was forced to leave Nottingham Castle, where she was staying, on account of the objectionable smoke from the sea coal. During Elizabeth’s reign the ladies of the land supported the Queen in her dislike of sea coal, and many would not enter houses where it was burned, or partake of a meal cooked over a sea-coal fire. To the end of her reign coal was used mainly by artisans and the poor, who could not afford to buy wood.


A current Pittsburgh survey through a WPA grant extending from April through November 1938 is described.

1942


Many investigations of smoke damage during the last 2 decades have placed an overvaluation on the chemical analysis of air in the neighborhood and have not given proper weight to the examination of the objects suffering from damage. Observation of damage is quite as important as analysis for sulfur dioxide, said to be the most widespread plant poison. In the case of dust, its arsenic content is the determining factor as to the harm in which it partakes. In the case of leaves the arsenic content corresponds to the damage inflicted. Compounds of fluorine are important, as many plants are very sensitive to them. It is only when actual damage to plants themselves is studied that an estimate can be made as to the harmful effects produced. This is of more value than merely negative testimony drawn from atmospheric analysis for sulfur dioxide. (FA)


“No Clean City” shows, by a series of statements and quotations from important authorities, how the purposes of postwar town planning will be frustrated unless they include measures for securing a clean and healthy atmosphere. It describes how smoke prevents the fulfillment of the basic needs of the town dweller for health and cleanliness, and how the smoke of the towns even frustrates the needs of the land. Stressing also the need for waste prevention, the importance of which has been very thoroughly taught by the present war, the pamphlet says that the smoke problem is a story of sheer waste from beginning to end. It is a waste that injures the Nation as a whole, as well as those who suffer directly from the smoke itself. In the first place, smoke is derived from the volatile portions of coal that might have been extracted to produce useful byproducts. (2) This volatile material might have been burned, as it could have been with proper apparatus and control, to produce heat. (3) The smoke, by the dirt that it produces and the damage that it causes, necessitates the continuous expenditure, on a heavy scale, of money and labor that might have been utilized for the production of new goods and services.

1943


The proceedings of the conference included the reading and discussion of a paper entitled “Unholy Smoke,” and resolutions for submission to H. M. Government and Ministries and to local authorities. (FA)

1944


City planners have recognized smoke and soot as among the principal evils of the large city as a place to live. The effects of smoke and the problems faced by city planners today are discussed.

Failure of smoke-abatement efforts to bring more satisfactory results is due to incorrect estimate of the kind and size of the job. When an industrial community realizes that keeping the air clean is a project of similar magnitude to keeping streets clean, providing clean water, removing city waste, or guarding the moral atmosphere, there may be real hope for success.

1945


Atmospheric pollution from coal combustion takes three forms: (1) Black smoke; (2) dust and grit; (3) sulphurous gases.

(1) Public health act of 1926 has minimized emission of black smoke from factories by penalization. Other factors include growing electrification and traction. Smoke from domestic stoves and coal waste than factories, though modern grate and stoves have brought about much improvement. Further decrease in smoke could be effected by using low-temperature coke or, in special cases, activated coke. A second point of provision is made for the combustion of volatile tars in secondary air. The Government's Housing Manual draws attention to the problem. (2) The worst offenders are powered-fuel boiler plants. Distribution of dust depends on the wind. Reversal follows the principles of eddy diffusion worked out by Bosanquet and Pearson. The use of cyclones even with a water spray is not altogether an effective trap, better results being obtained by electrostatic precipitators or water washing. The former method guarantees over 90 percent efficiency. The latter has caused many problems to arise but efficiency is now very high through the use of the Modave duster which is being improved still further. (3) SO, passes into the air and is deposited as H,SO, which causes much damage to anything it contacts. So far little general official action has been taken to mitigate this evil, though it is expected. In the case of concentrated amounts of SO, recovery by washing with basic aluminium sulphate is practicable, but there is no economical method for recovering small concentrations. Battersea Power Station eliminates 90-95 percent of SO, produced by a system of water sprays and baffles, absorption being assisted by catalyzing oxidation with iron.

Corrosion of the apparatus is prevented by alkaline Thames water. The Fulham power station prevents corrosion by the use of chalk and crystalline calcium sulfate in the circulating liquid. These methods are too expensive for general use, but attention could be paid to the secondary action of the Modave duster which involves the removal of up to 30 percent sulfur.

(FA)


During the 3 years 1937-39, three officers of the Department of Scientific and Industrial Research were engaged fulltime in making systematic observations of atmospheric pollution in the City of Leicester, with the full cooperation of the city authorities. The object was not only to obtain information about the distribution and dispersal of atmospheric pollution which would be peculiar to Leicester, but to obtain new basic knowledge about atmospheric pollution which would be of more general application. The present report is an account of the results of this work and of the conclusions, whether of special or general application, which may be drawn from them.

A survey of pollution in Leicester was therefore devised: (1) To measure and investigate the distribution of atmospheric pollution in the neighborhood of an industrial town; (2) to determine the principal agents causing atmospheric pollution; (3) to measure how atmospheric pollution varies with the habits of the population and with meteorological conditions; and (4) to find out how pollution escapes from the atmosphere of a town.

It has been possible to estimate both the mean distribution of pollution in and around Leicester and the variation in distribution caused by wind or otherwise. The daily, weekly, and yearly cycles of atmospheric pollution have been examined and compared, and also a particular study has been made of the very large day-to-day variation of suspended impurity. In contradiction to the general impression that this day-to-day variation is mainly due to variations in wind velocity, the conclusions point to turbulence as the chief cause of the variability.

The control of sulfur dioxide is bound up with smoke abatement, but the methods of voluntary control are more difficult; and natural processes that limit the concentration of sulfur dioxide in towns are not the same in all respects as those that limit smoke.


Three types of nuisances are discussed: Inert smokes and dusts, mucous membrane irritants, and malodorous substances. Sulfur dioxide is listed as the chief mucous membrane irritant. Others are chloride and phosgene and acid mists, such as sulfur trioxide and hydrogen chloride. Handling of the problem of air pollution requires two basic fundamentals: (1) Public relations and (2) technical study of the problem. Attacking a legitimate nuisance complaint requires coverage of seven features, which include identity of causative agents, establishing sources, sampling air for concentration, study of factors affecting dilution, interpretation of results, and securing corrective measures.

(USPHS)


This is a review of the effects of smoke on health and appearance of urban communities. The methods of measuring smoke pollution are discussed. The Ringelmann chart, photoelectric smoke density meter, and Owens air filter are each described. The article concludes with a brief discussion of the smoke tendency of various fuels. (JHT)


In this second abridged report of the New York City Air Pollution Survey the methods employed in making the surveys of fuel consumption and of fuel-burning equipment are outlined. The former includes surveys of marine, automotive, railroad, industrial, commercial, and residential fuel usage to obtain the quantity of each type of fuel used. The fuel-burning equipment survey gave data useful in checking certain figures obtained in the fuel survey and also gave much material of value to the Health Department in its air-pollution abatement work.

From these basic data, maps of the city have been prepared showing: (1) The total solid fuel consumption, (2) bituminous-coal and fuel-oil consumption, and (3) total fuel consumption in various districts of the city. These are taken as indexes of potential cinder production, smoke production, and gaseous pollution.
production respectively. They are shown to correlate very well with a similar map based on the average monthly sulfate in the same districts. (JIIF)


The following are discussed in detail: (1) Sources of air contaminants; (2) effects of air contaminants on health and efficiency; (3) detection and measurement of air contaminants; (4) control of dusts, fumes, smoke, air pollutants and gases by: (a) General ventilation, (b) ventilation of isolated areas, (c) local exhaust systems; (5) provisions for adequate conditioned air supply; (6) methods of preventing excessive heat loss due to wintry ventilation; (7) performance of dust collectors; (8) performance of fans, blowers, air ejectors, and natural draft ventilators; (9) control of hazards by substitution of safer materials and alteration or isolation of processes; (10) metallic and organic dust explosions—necessary preventive measures; (11) temperature, humidity, drafts, and radiant heat; (12) significance and control of odors in industrial establishments; (13) control of airborne bacteria by ultraviolet radiation, germicidal mists, and fumes; (14) personal protective equipment; (15) methods of determining effectiveness of air sanitation equipment; (16) standards, regulations, and codes on air sanitation and ventilation. (APB)

1946


Report is made of survey of heating and power plants in Toledo by the Coal Producers' Committee for Smoke Abatement. The engineers of the committee surveyed 180 plants.

Much of the smoke was attributed to carelessness or lack of knowledge of the smoke they were making on the part of most firemen. Also, bad equipment, poorly operated, was a factor.

The atmosphere in Toledo, however, was relatively clean owing to location on level ground with no “basin” to hold the smoke or fog. The direction of the prevailing winds toward the lake tends to get rid of most of the smoke and fly ash as they are produced.


In the British House of Commons the Minister of Health said that the Department of Scientific and Industrial Research have not yet obtained evidence to show that there has been any significant change over the country as a whole during recent years in regard to atmospheric pollution caused by soot and smoke.

(ABP)


The British incendiary bomb was filled with a special benzol gel and white phosphorus. The benzol-gel filling produced, on burning, a large amount of black smoke, which obscured the target and resulted in an appreciable portion of the filling being wasted as unburned carbon. In addition, copious white smoke produced by the burning phosphorus increased the obscuring effect over the target. The possibility of replacing this benzol gel-phosphorus combination with a smokeless filling of a suitable particle size was therefore investigated. The smoking tendency of a large number of organic compounds was assessed by flame-height measurements in a special lamp based on the I. P. smoke lamp. A burning organic substance has a flame height at the surface which, smoking occurs, and this height is a measure of the tendency to smoke. A new form of lamp was devised to measure flame heights, from about 9 to 450 mm., of liquid compounds burning freely in air. A wide range of hydrocarbons, alcohols, ketones, esters, and nitrocompounds was examined—115 compounds in all. In general, a compact molecular was found to give a smoky flame. The order for increasing tendency to smoke for hydrocarbons is: n-Paraffins (in which increased chain length or chain branching gave increased smoke), naphthenes, olefines, and aromatics (in which appreciable aliphatic sidechains on the benzene ring appeared to give no marked reduction in smoke). In general, increased oxygen content of an organic compound resulted in decreased smoking tendency and compounds, such as methyl acetate, containing high percentages of oxygen only smoky at very large flame heights. Some compounds, such as allyl alcohol, although having appreciable oxygen contents, had relatively high smoking tendencies, due to the nature of the carbon-hydrogen portion of the compound. Of the aliphatic alcohols, the tertiary compounds were more smoky than the primary compounds. This also applied to nitroaromatics. For each set of isomeric aliphatic esters, the flame height at which smoking began increased with the chain length attached directly to the carboxylic acid. At equal oxygen content, the general order for increasing tendency to smoke was: n-Primary alcohols, n-Primary nitroaromatics, propionate, acetaetes, lactates, and formates, although the order varied slightly for different oxygen contents. (FA)


Forty-six specific contaminants are covered, including benzene vapor, carbon monoxide, gasoline vapor, hydrogen sulfide, and sulfur dioxide.


Substances suspended in the air or dissolved by it would be called generally atmospheric dispersoids, aerodispersoids, or simply dispersoids. Aerodispersoids would be classified into four groups: (a) Dusts. A generic name for all solid particles of any size, nature or origin, suspended or capable of being suspended in the air. (b) Fluids and condensed vapors (or sublimates). A generic name for any kind of fluid (drops of oil) or vapors, foreign or not to the atmosphere composition, and not dependent on temperature or pressure. (c) Gases and noncondensed vapors. Covers every kind of gases and vapors, which are not condensed, capable of polluting the atmosphere. (d) Smokes. A complex mixture of various composition dusts, gases, and vapors, whether or not condensed, resulting from the combustion of organic substances to a more or less incomplete degree (coal fumes or almost colorless smoke (black or white smoke) with all the intermediary shades). (FA)


Smoke production during the burning of hydrocarbon gels has been investigated. The weight of smoke formed has been determined and the obscuring power of the smoke cloud measured by an optical density method. The burning behavior of the gels were also examined. These burning characteristics have been assessed by determining the unburned residue resulting from the combustion of a constant weight of gel with a constant burning area exposed, together with
the time of burning and maximum and mean flame heights. The effect of the following variables on the above measurements is discussed and discussed in detail: (1) Chemical composition of the hydrocarbon base; (2) volatility of the hydrocarbon base; (3) viscosity of the gel. For reduction of smoke formation, the composition of the hydrocarbon base was found to be most important, while the volatility was equally important in controlling the burning characteristics. The viscosity of the gel had no apparent effect on the smoke production. (FA)


Some factors are presented indicating the desirability of smoke abatement. The St. Louis project is cited. Smoke reduction is shown in percentages after the enactment of smoke abatement legislation. Direct monetary losses due to smoke, which include clothing cleaning bills, painting, refinishing, house and building cleaning, and loss in merchandise, are given. Mentioned also are increase in medical-care costs and lowered morale. Attesting to the value of smoke abatement, many statements of various physicians are quoted as testimony to the decreased incidence of mucous membrane irritation, colds, sinusitis, and infections of the tracheobronchial tree. Eye specialists are also quoted as to no reduced irritation of conjunctiva and infection. The reduced difficulty in keeping buildings and grounds cleaned with a great reduction in carbon deposits is a noteworthy effect of smoke abatement. Businessmen are quoted as to the reduction in cleaning costs and the reduced loss of merchandise. It is estimated that savings in light bills amounted to $75,000 a year. (USPHS)


In Minneapolis, as in other cities, not only the better classes of residents but also industries are moving away from central sections of the city on account of smoke pollution. Food-processing industries and others acquire clean air for their work. Thus smoke abatement has become a vital factor in city planning. (FA)


Primarily a summary of work done during many years on the atmospheric pollution of the air of London. By way of introduction, the present knowledge as to statistics of the source and quantity of atmospheric pollution throughout the country is summarized, with considerations as to its deleterious effects and cost. The methods of measurement are then described and conclusions arrived at on the basis of work done. First, the variations in the degree of atmospheric pollution throughout the day and the year, and then through the period of years are discussed. The approximate similarity in the degree of pollution in the air of London and Glasgow is demonstrated. Finally a short section is included as to possible means of mitigating the evils of atmospheric pollution in future. (APB)

127. SMOKELESS AIR. Atmospheric Pollution In Sheffield, Rotherham and District. No. 2, 1946, pp. 17-18.

At the beginning of 1944 pollution figures in this industrial area had increased by more than 50 percent over those in 1939, while average smoke emissions per observation had increased sixfold. Many of the works find that the fuels supplied vary to such an extent that continuous adjustments of working conditions are necessary. Out of 550 boiler houses, about 500 are mechanistically stoked, and many others would convert if they could obtain early delivery of the materials required. Perhaps the worst feature to record is that of taking mechanical stokers off boilers and fitting them with forced-draft hand-fired furnaces, creating a bad smoke nuisance and reducing the boiler efficiency in order that a poor grade of fuel can be used. Complaints have been made of nuisance from four large electricity power stations in the Don Valley; and from the fuel figures supplied it is estimated that 1,175,000 tons of fuel per annum are burned, emitting about 107 tons of sulfur to the atmosphere each day. Since June last a leasing clause has been in operation in Sheffield, making it an obligation for all leases to submit plans of heating apparatus. (APB)


Fifteen papers are presented, covering a variety of topics. The larger aspects of smoke abatement and fuel conservation are considered in the first group. Succeeding papers dealt with such specialized fields as dust collection, the relation between meteorology and smoke abatement, the design of locomotive equipment, coal analysis, and incineration problems. An outline is submitted as a suggested approach to participation of the Weather Bureau in air-pollution research. (FA)

1947


The composition of smoke, its origin, disposal, causes, and effects are discussed as well as its prevalence, methods of measurement, and remedial measures available. Comment is made on the widely variable composition of “smoke” and the great variation in the amounts of material suspended in and deposited from air in different circumstances. (APB)


A study is made of the geographical distribution of pollution over Britain as measured by the deposited matter collected in pollution gages. The results are shown in tabular and graphic form and the effects of smoke pollution on town and country life are discussed. (FA)


The Fuel Research Station showed furnace fronts from a forced-draft Scotch marine boiler in a natural-draft Lancashire boiler; also an atmospheric pollution exhibit showing work on measurement of smoke, sulfur dioxide, and loss of sunlight, and a boiler availability exhibit. (APB)

132. COAL-HEAT. Recommendations for Abatement of Smoke and Atmospheric Pollution. No. 5, 1947, pp. 28-29, 52.

A survey of Toronto’s atmospheric pollution problem is reported, in which it was found that heavy industry, manufacturing, and commerce contribute to the problem in the order named and that much of the smoke comes from the burning of wood waste, sawdust and shavings, and refuse. A total of 145 plants was surveyed, including 256 boilers and 802 individual pieces of heating equipment, and analysis was made of other factors that contribute to atmospheric pollution, such as topography, wind velocity and direction, and industrial diversification. Fourteen recommendations are offered. It is suggested that the quantity of smoke from domestic sources is usually overestimated. (FA)
GENERAL ASPECTS OF AIR POLLUTION


This survey discloses basic facts on the numerous sources of air pollution in and around Philadelphia, and the report makes statements, observations, and recommendations with respect to necessary preliminary steps toward initiating an air-pollution-control program. The Appendix includes a suggested draft of a model air-pollution-control ordinance. (FA)


A survey of 396 plants is reported, and an analysis is made of the factors contributing to atmospheric pollution such as wind velocity and direction, topography, industries, and smoke-stacks. The report recommends the following steps: (1) a comprehensive study of combustion and consumption, hearing characteristics, etc.; (2) a study of the most effective legislative approach; (3) a study of the effects of Detroit's air-pollution problem. (FA)


The report covers the combustion of sulphur, toluene, control, and benzole recovery, smoke abatement, and discharge of gases and fumes from registered and unregistered works during the years 1939-45 and the steps taken to prevent excessive discharge. (FA)


This investigation was planned as a preliminary study that would disclose some of the important points of the local air-pollution problem and could serve as the preliminary for a future comprehensive study having the following aims: the determination of the nature, extent, and cause of atmospheric contaminants causing eye smarting and lachrymation, and of those responsible for reduced visibility increasing aviation hazards, measurement of the nature, extent, and degree of air pollution and evaluation of the importance of the smoke problem to the whole problem of air pollution in the county and development of an effective approach for regulation of discharge of aerial wastes other than smoke in metropolitan Los Angeles. The present report contains a preliminary summary of the scientific investigations and an analysis of the accomplishments and findings of the work performed to date, and recommendations are made as to future studies. Special emphasis is given to the collection of scientific study, source study, vital statistics and air pollution, and analysis of Weather Bureau data. (APB)


The various industrial sources of atmospheric pollution are discussed and suggestions are given as to the elimination of the nuisance. Offending industries include the aluminum and rayon industries and the refineries. (FA)


The smoke problem divides itself into two parts, the smoke problem and the dust problem. Several years ago Pittsburgh undertook an elaborate dust collection, extending over 3 years. The deposited material from 100 locations was weighed and analyzed for volatile material, fixed carbon, ash, iron, silica, and sulfur. Customary dust-collection methods were also used. The data have yielded nothing definite regarding the efficiency of combustion in the city. Thus it has been verified by a more recent test with an electric precipitator and a recording tape, during and after a steel strike, which the mills were not operating. With the mills off, the record showed 1.77 arbitrary units of dust per hour. With the mills at 60 percent capacity, the figure was 1.61 and at full operation, 1.85 units. The difficulty with this test was that most smoke or dust is recorded mornings and nights, when atmospheric inversion produces moisture which carries the dust with it. In the dust-collection tests, the deposited material includes organic and inorganic dusts that have blown from some distance, and the volatile matter and fixed carbon includes constituents of the organic dust. On Sundays and holidays under a heavy atmospheric lid there was a heavy deposit, while on clear working days the deposit was light. Therefore a dustfall really measures weather conditions and is not a true measure of combustion. Direct visibility tests, such as are constantly made by the United States Weather Bureau, likewise do not measure smoke pollution, because there is no instrument that will differentiate smoke from dust, fog, and haze. The Weather Bureau observations, then, should be called"visibility record"or"air-pollution" rather than"smoke observation." Also, the points of observation are too few to give a representative picture of conditions over the city. (FA)


A trend toward adoption of more stringent local smoke-control ordinances and more effective enforcement of existing ordinances, which tends to spurt conversion to automatic heating equipment, is spreading throughout the country despite fuel-supply difficulties, a survey discloses.

Omaha is among the cities most recently adopting new smoke-control ordinances. Other cities that have recently adopted stringent smoke-control ordinances, which in a number of instances also regulate the emission of soot, dust, and poisonous fumes, include Detroit, Richmond, Akron, Salt Lake City, Providence, Niagara Falls, and Cincinnati.

In New York City's efforts to fight smoke, contracts involving expenditures of $8,062,400 to eliminate the smoke nuisance have been let by 102 privately operated heating plants. Consolidated Edison has authorized an expenditure of $5,400,000 for correction of smoke and other conditions at all its power stations. Other improvements contemplated are listed as ranging from $500,000 by the American Telephonic and Telegraph Co., to $200 to $500 by owners of small apartment houses. Reference is made to other cities that have passed ordinances or taken steps toward more effective enforcement of existing smoke-control ordinances.


Standard procedures in most smoke-abatement programs, with familiar patterns of approach and general types of legislation, are pointed out. The whole matter often becomes highly controversial and the original aim, to reduce the amount of atmospheric pollution, becomes lost. The failure of data taken from a few dust- or soot-deposit stations, as well as the inadequacies of the Ringelmann chart, are stressed. Other methods and means of identifying pollution through visible contaminants are regarded as unsatisfactory.

Atmospheric conditions and the invisible products of combustion play a major role in atmospheric pollution. Wind velocities, temperature inversions, and the occurrence of considerable study. The concept of air volume in air pollution has received very little consideration. Intol-
erable or even very annoying atmospheric pollution is caused mostly by the invisible gases and various types of combustion than by the visible particles in the air. These gaseous products of combustion cannot be overrated, as on the average, there are at least 50 times more of these gaseous particles of combustion in the atmosphere than there are solid particles.

Condensation nuclei and the causes of their formation should be given considerable attention. All combustion processes, whether the fuel be solid, liquid, or gaseous, will contribute these condensation nuclei, and their overwhelming excess and their relationship to the ever-changing weather conditions represent a much more complex and important aspect of the problem than does the presence of visible contaminants.

The subject of atmospheric pollution has not received the consideration that its difficulty and importance demand. Unless smoke abatement is based upon a painstaking and unemotional research program the activities of legislation and agitation can do little to solve the problem. Greatly needed is a carefully planned program of investigation and research considered from the long range point of view. The subject requires the combined efforts of many skills and many professions. Solution of the problem lies in a truly modern research program in atmospheric pollution. (CLAC/UCLA)


The civic trend is to require more and more from Industry in air-pollution control. Management generally desires to reduce contamination if it is convinced that there is excessive pollution from its operations and that it is economically feasible to abate the condition. Industry would be well advised to anticipate the effects of the civic trend by assuming the lead in sponsoring urgently needed research. Cooperation with public agencies is also advisable to insure that regulatory actions are based on sound engineering principles. The primary basis for control is the welfare of inhabitants of a community, but gains in this respect will be limited if regulations are impractical. Relations permitting interpretation of community standards of atmospheric pollution in terms of health should do must be developed and emphasized. The difficult problems in the control of atmospheric pollution are economic; the most serious are those problems in which the cost of the only known methods is out of proportion to the value of the resulting operations or the magnitude of the nuisance. Industrial pollutants are classified according to their outstanding physical properties. A scheme is presented which is suggestive of procedures for measuring different types of pollution. Control of industrial pollution is effected by tall stacks and by chemical-engineering techniques. Stacks approaching 1,000 feet in height may be practical in certain situations. Meteorology, by identifying the most effective "air streams" for dispersing contaminants into the atmosphere, can aid materially in the selection of new plant sites which have difficult problems of gaseous waste disposal. (APB)


The United States Public Health Service studied air pollution in Chicago as a part of a survey of health conditions requested by the city and county governments. The report referred to the surveys on dust which have been made for many years. Each month analyses of dustfall precipitation are still being made at the stations in Chicago. The monthly average per square mile of dustfall for 1945 varied from 222.10 tons at 22 North La Salle Street to 24.06 tons at 7350 Pratt Boulevard. The average monthly dustfall per station was 68.40 tons per square mile, and this was a decided improvement, as shown by the records of 20 years ago.

The control of air pollution is difficult. About 1,200 locomotives, 25 roundhouses, 450 steamship arrivals per season, 400,000 buildings, and other miscellaneous items contribute to the smoke problem. The United States Weather Bureau reported that in 1946 Chicago received only 56 percent of the possible hours of sunshine. Smoke alone is not responsible for this percentage, but combined with fog and partial cloudiness, is a factor in the sunshine record. Chicago has a department of smoke abatement, but the appropriation for this department in 1948 failed to provide adequate personnel to observe all smoke violations and nuisances in the department's seven districts. It is recommended that the Cook County Commission conduct a survey with a view to establishing rules and regulations for smoke abatement and control of air pollution, and that the industrial communities in Indiana near Chicago—Hammond, Whiting, Gary, Indianapolis, Indiana Harbor, and East Chicago—be urged to adopt effective legislation for smoke control and the abatement of smoke nuisance.

Railroads, it is estimated, account for about 25 percent of the city's smoke.


The Coal Producers' Committee for Smoke Abatement made a survey of the heating and power equipment in seven areas selected for study for the Air Purification Committee of Cleveland. In addition, a cursory analysis was made of the Cuyahoga River Valley and its various industries. The purpose of the survey was twofold: (1) To determine the principal sources of smoke and pollution and (2) to make general and specific recommendations for its elimination. Recommendations for smoke elimination are made and details of the contributory causes of smoke are enumerated. (FA)


The Coal Producers' Committee for Smoke Abatement has made an engineering survey of heating and power plants in Detroit. The survey embraced a study of over 500 installations of fuel-burning equipment. The survey indicated clearly that the domestic furnace-burning plants are responsible for only a very small portion of the total annual air-pollution nuisance in Detroit. The actual and potential offenders are listed in order of nuisance. The causes of the pollution in Detroit are outlined and recommendations are offered for its elimination. (FT)


A brief historical survey is made of experimental work on aerosols from 1871 to 1943, and their properties are given. The chief methods by which they can be produced are described and the essential features of a practical commercial apparatus are enumerated. The Phantomser equipment, which embodies these features, has proved extremely effective when used with the correct liquids. (APB)


This report is presented under the following headings: Assistance to cities in air-pollution control; State legislation; enforcement activities; complaints; smoke observations; advisory boards (railroad smoke abatement, diesel-smoke abatement); diesel-truck statistics; air-pollution board on agriculture; research and investigation, staff studies, accomplishments and findings, and utilization of findings; and costs. (FA)

The total smoke produced a year in Great Britain is estimated at 2.3 million tons, of which approximately half is from domestic grates. The total pollution by oxides of sulfur is about 5 million tons a year, of which one-fifth is from domestic appliances burning raw coal. The Leicestershire district in Leicester was found to be the center, and the maximum effect of wind was to move the point of maximum smoke concentration ½ mile down wind. Three-quarters of the smoke emitted in winter in central Leicester came from domestic chimneys. In spite of Leicester being isolated from other industrial towns it was found that 10-40 percent of the pollution in central Leicester was derived from outside areas. The mean smoke concentration at the center of Leicester was 0.17 mg. per cubic meter in summer and 0.41 in winter. Sulphur dioxide is removed from the air by natural causes more rapidly than smoke. The smoke-sulfur ratio is a useful aid for observing variations in pollution. The least smoke per ton of coal burnt in Leicester was produced at the center, and the highest in the inner suburbs. Smoke is due to imperfect combustion, particularly to tarry vapors. In a hand-fired boiler the evolution of combustible matter is not complete, and is maximum at the rear of the grate. Smoke eliminators have been designed at the Fuel Research Station for forced- and natural-draft marine boilers, and for Lancashire boilers, which introduce by simple means enough secondary air at these periods of increased evolution of combustible matter. Tests made show that when heavy smoke is made, about 2 percent of the heat may be wasted as visible smoke, and an additional 6 percent wasted as combustible gases, such as carbon monoxide, hydrogen, and methane. The most efficient operation is obtained when only light smoke is made, the heat loss due to incomplete combustion increases at a rapidly accelerating rate as the smoke density increases. Reduction in domestic smoke can be achieved by designing more efficient appliances and using smokeless fuel. Grit or fly ash from boilers can be removed by standard apparatus such as cyclones, electrical precipitators, and water washers. The type of fly ash is influenced by the system of combustion, dependent on whether the ash spheres are formed from ash particles lifted from the fuel bed, or from the combustion of fine coal suspended in air or flue gas. No satisfactory method of universal application has been found for smoke pollution is reduced. Certain power stations have been equipped with systems for removing sulfur dioxide, but the processes are difficult to operate, and on a prewar basis cost 2-3 shillings per ton of coal burned. (APB)


Subsidies due to mining and smoke abatement are discussed. Maps show location of gas and electricity undertakings. (APB)


Three points of view must be considered in attacking the problems of smoke and fume control: That of the plant owner, the employee, and the plant's neighbors. A "neighboring" area is not necessarily an adjacent area, and the problem of smoke, dust, and fumes is not one that can be escaped by removing a plant to remote locality. The value of cooperation among plant owners, the public relations department, and the public is assessed. The effect of fumes on the respiratory system and on vegetation and the critical role played by the weather in the disposition of fumes are discussed. Various methods of combating fumes are given and the operation of a portable laboratory for making tests in the neighborhood is described. (FA)


Atmospheric pollution is discussed, with particular reference to Middlesbrough. (FA)

1948


A discussion of air conditioning and atmospheric pollution. (FA)


This symposium consists of 44 papers grouped under four main sections: (1) Methods of sampling air for bacteria. (2) Air disinfection by chemicals. (3) Measurement of contamination of air living organisms. (4) Transmission of study of airborne infection in animal experiments. (FA)


About 150 tons of solid deposits fall over every square mile of the West Riding each year. The adverse effect of this fall is noted by the health authorities. The whole answer is not in the quantity of coal burned, but in the compulsory use of smokeless by households and industries would have far-reaching results. (APB)


The report shows for the year ended June 30, 1937, a total sootfall of 413.8 tons per square mile in Cincinnati, against 453.4 tons for the year ended June 30, 1946. This is a reduction of 7.4 percent. Detailed statistics are derived from monthly samples taken from 20 collecting stations by the City Bureau of Smoke Inspection. The deposits are established on the basis of 1 square mile for each station and an average weight established for the entire city. (FA)


In reply to question, it was said that the reduction of smoke in the air would not prevent fog, but it should reduce their intensity and frequency. The Fuel Research Station of the Department of Scientific and Industrial Research had studied methods of reducing the emission of smoke by using fuel more efficiently. Smoke eliminators developed by the station for hand-fired industrial boilers were being marketed commercially. Research on the design of domestic appliances and on the production and use of smokeless fuels was in progress, but this was essentially a long-term problem. The department had also, over many years, organized the measurement of smoke pollution to assess any change in its distribution and intensity. (APB)


The investigation was planned as a preliminary study which would disclose some important points of the local air-pollution problem and could serve as the pre-

In a leading article, it was stated that the traditional ways of burning coal in Britain give the domestic consumer far less value for his outlay than the consumer enjoys in America and many parts of Europe. In 1938 British homes and industries released into the atmosphere about 2,400,000 tons of smoke, nearly 600,000 tons of ash, and over 5 million tons of sulfur dioxide. The fossil-fuel and material damage caused by this pollution cannot have been worth less than £45,000,000. The domestic consumer alone paid out of his pocket some £4,000,000 for the privilege of producing 1,500,000 tons of smoke from soft coal. The cleaning and redecoration of houses and shops necessitated by atmospheric pollution are believed to have cost £5,000,000, while the additional expenditure on laundry and renewal of curtains attributable to the same cause is put at £18,000,000. Many of the Sinn and Factory reports, recommendations still wait for official action, but the Ministry of Health last week took the sensible step of forbidding local authorities to install outmoded grates and stoves in their new houses. They must in future choose their solid fuel appliances from the list approved by the Government as efficient; some of these are designed only for the burning of smokeless fuels, but most can use either soft coal or smokeless fuel of some kind. It is hoped, but not yet ensured, that councils replacing old grates and stoves in existing houses will buy their appliances from the approved list. There is much more to be done, as the supply of fuel and appliances improves, even if the Government stops short of the Simon report's suggestion that "the manufacture and sale of new appliances falling below approved standards should be prohibited as soon as practicable." More could be done even now. It is strange, for instance, that the standards now imposed on new houses should not also be applied to houses built or converted privately. In matters of fuel economy and smoke abatement there should be only one standard for all new dwellings, without regard to their ownership. **(FA)**

The very desirable goal of reduction of atmospheric pollution in cities is sometimes confused by the entrance of the local politician who is hungry for the votes of groups of citizens urging improvement but almost totally ignorant of scientific means of smoke abatement. The usual result of a condition of this kind is to make the problem more difficult. The reduction of atmospheric pollution is a long-range program that must be dealt with city planning. To conduct a program properly, industry either must take the entire city or the civic-minded engineers must cooperate with municipal authorities in setting up the program. Once set up, the program must be guided constantly by citizens who are qualified by experience to cope with the problems that arise. The Coal Producers Committee for Smoke Abatement has surveyed a number of cities and presented their findings to citizen boards. Their findings of many defects in industrial plants and their recommendations for improvement are reviewed at some length. The development of a smoke ordinance in Erie, Pa., and establishment of an Industrial Board along the lines recommended in this paper are described. **(API)**


Quotations from official sources of the damage caused by smoke are given. **(APB)**


The problem of atmospheric pollution is dealt with exhaustively, starting with many reasons why the
natural purity of the atmosphere should be restored. Some causes of increased grit emission are given, and attempts made to minimize the nuisance are discussed. The F. R. S. smoke eliminator is described. (FA)


This report is restricted to atmospheric pollution, excluding air pollution in enclosed spaces, except as they may affect the outside atmosphere. The investigations conducted by various cities are discussed, and the effects of dust, smoke, gases, pollen, and radioactive materials, are considered, with some attention to sampling and measuring devices. Nuisance odors and their possible measurement are discussed. Preventive measures, especially as involved in municipal legislation, are summarized, and increased attention at all government levels is advocated. (APB)


Observations in the area of Meaford power station, Stone, Staffs., in the last 6 months, show that there is not excessive pollution of the atmosphere. Further tests are to be taken to confirm the accuracy of these reports as there are plans for more power stations in the same neighborhood. (FA)


In a survey covering the problems of air pollution, pickle liquor, atomic wastes, etc., waste procedures from byproduct coke plants and efforts made to remedy pollution by these plants are discussed. (FA)


Effects of atmospheric pollution, methods of control, and the need for cooperative efforts by many groups are discussed. (APB)


The universality and complexity of the problem are pointed out. Two broad phases of the problem—effects and contaminants—are analyzed.

Under effects are considered the nuisance aspects, economics and effects on vegetation, animals, and health. Contaminants are discussed under the heading of source, methods of control, and ordinances. Cooperative efforts of many groups will be required to obtain the basic information that is necessary to develop a progressive atmospheric pollution program. Only by an intelligent, concerted approach to this problem can those reasonable conclusions be reached that will permit industry the right of operation, and the community the right to have an atmosphere that is relatively free of atmospheric pollution.

174. COAL-HEAT. Seasonal Variations in Dustfall and Other Factors Related to Air Pollution. Vol. 55, 1949, pp. 9, 10, 12, 14.

A chart is given to show seasonal variations in temperature, precipitation, dustfall, wind velocity, coal consumption, and the visibility measure, “haze, smoke, dust,” in Chicago. Various conclusions are drawn, one being that variation in dustfall, following more closely that of wind velocities than that of coal consumption, is not so much due to factory, locomotive, apartment building, and home chimneys as is usually thought. (FA)


A review of the smoke problem, with particular reference to the nature of smoke, its consequences, and methods of prevention. (FA)

The British Electricity Authority has advised research work by the National Physical Laboratory into problems arising from the emission of smoke and dust from the Notting and power station, Sheffield. One suggestion is that chimneys of about 400 ft. height might carry the emissions over the surrounding hills, but to build one chimney of this height would probably cost from £60,000 to £70,000. At a meeting of the Sheffield Health Committee it was decided to ask the B. E. A. to end the nuisance caused by sulfur fumes and grit from the Peepsend and Blackburn Meadows power stations, and it was reported that the average monthly deposit of solid matter in the Wilna-land area last year was more than twice as much as in 1932, while the sulfur content had increased by 56 percent. Under certain conditions the fumes were so potent that people in the district were compelled to protect their eyes.


This is the report of the Atmospheric Pollution Research Committee for the 5 years ended March 31, 1944. In 1927, the Department of Scientific and Industrial Research accepted responsibility for coordinating local observations of atmospheric pollution, and for conducting research into the nature of the pollution and the best methods of measurement. Thereupon, an Atmospheric Pollution Research Committee was appointed to give the department expert scientific advice on these matters, and arrangements were made for the setting up of a Standing Conference of Cooperating Bodies to maintain effective touch between the central organization and the local authorities and other bodies who are assisting by making financial contributions or by maintaining observations. In addition, therefore, to the data collected during the 5 years ended March 31, 1944, and to the report of the Superintendent of Observations thereon, the present volume contains, as usual, the report made by the Standing Conference to the Cooperating Bodies on their proceedings during that period, together with the report of the Research Committee.

The report consists mostly of tables and charts giving such data as mean rates of deposit, trend of deposited matter, sulfur measurements, yearly cycle of suspended impurity determined with the automatic filter and the daily smoke filter, percentage of available data, and daily cycle of smoke and changes in atmospheric pollution during the war years.

A great part of the committee’s time during this period was devoted to consideration of the draft of the Report on the Leicester Survey. This survey was planned and supervised by the Atmospheric Pollution Research Committee with the assistance of the city authorities. The results were published in 1945 as Technical Paper 1 by the Department of Scientific and Industrial Research.


This report presents statistics on sootfall in different locations in the area and in other areas, with meteorological data. The conclusions state in part: “The atmospheric pollution problem in this area is of sufficient magnitude to warrant serious consideration of plans for an overall and area-wide atmospheric pollution control program, not merely smoke abatement. Studies of the various gases, vapors, and mists in the air, in addition to the sootfall studies reported, would be highly desirable for future guidance. It is desirable that the records be continuous, so as to evaluate the beneficial effects of any improvements made and to furnish additional technical data for a scientific approach to formulating atmospheric pollution regulations. However, a definite goal should be established in order that the studies will yield the most value for money invested.” (FA)


The lack of regard for the ever-increasing problem of disposal of water-borne and air-borne industrial wastes in the siting of areas of industrial activity and in the designing of industrial plants is cited. A striking similarity in the areas that experience the nuisance of atmospheric pollution is indicated by a table listing the location of some of the most important sources of air pollution.

The proper use of chimneys for the discharge of contaminants into the air to prevent nuisance and injury to the surrounding community is discussed. Reference is made to the excellent work that has been done in the application of meteorology to the sifting and design of chimneys. (12 refs. cited.)


Complaints about atmospheric pollution increased considerably during 1949. One was in connection with the emission of fumes from a plant producing elemental phosphorus. The Florida Industrial Hygiene Division suggested changes in operation which resulted in elimination of the cause of complaint.


The Minister of Health was asked if he was satisfied that the act of 1936 provided adequate powers to deal with the smoke nuisance; if he was aware, for example, that some 430 tons of solid matter per square mile per year, that is, 18.1 cwt. per day, fell on Birmingham; and if, in view of the inconvenience and deleterious effects on the health of residents, especially those who suffered from respiratory ailments caused by fumes from metallurgical processes and excessive smoke from factory premises, he would consider granting greater powers to the Corporation to deal with such offenders by way of increased penalties. The reply was that at the moment, it was not intended to review the law on these matters. (FA)


This chapter contains a comprehensive coverage of various aspects of atmospheric pollution, including causes, sources, and varieties (liquids, gases, and solids) of pollution, and the source, composition, and effects of smoke. In the description of the effects of smoke, photographs are included of lettuce and cabbage leaves which were grown from the same seed in both unpolluted air and smoke. Health implications are pointed out in the statement that “every medical officer of health of an industrial area knows that a rise in the death rate is to be expected after a smoke fog...” Graphs are shown for three towns correlating deaths from respiratory diseases with foggy days, temperature, and with weekly incidence of sunshine. The incidence of deaths was much higher in the town with the least sunshine (Leeds), although the temperature in all three towns was comparable. Measurements of smoke and sootfall are discussed at length, including methods of reduction and control. Although this report covers atmospheric pollution in Great Britain, a section
is devoted to a limited consideration of the same problem in other countries. (USPHS)


The survival of man depends on his ability to adapt himself to his environment. For thousands of years changes in man's environment resulted from natural causes beyond his control; he tried to mitigate their impact by migrating from regions that had become unfavorable to regions more favorable. Such attempts were not always successful, for various types of primitive man disappeared. About 100 years have passed since man has not become the nearly equal victim of toxic industrial wastes created by modern industry. Occupational diseases furnish a vivid example of the many and frequently serious new health hazards to which the industrially employed part of mankind has become exposed. The inclusion of some of these agents in consumer goods, such as foodstuffs, cosmetics, medicines, household goods and clothing, and their sometimes indiscriminate use have brought the general population into closer contact with the injurious factors in the modern industrial environment. Perhaps the most important and alarming aspect of the recent change in human environment is the increasing and often severe pollution of the air, soil, and water with both industrial wastes and regular products of industrial manufacture such as pesticides and coal and petroleum road tars and asphalts, injurious to health. The recent disaster at Donora called attention to the problem of air pollution by industrial gases and fumes containing sulfur dioxide, arsenic, and fluorine originating from smelters.

Experiences in the environment of some large copper smelters in the Rocky Mountain area attest that human beings are not the only potential victims of toxic industrial wastes released into the atmospheres. Fumes and gases from petroleum refineries are obnoxious to the people living in their environs; their odors are offensive and even nauseating. Such fumes contribute to the formation of the "smog" experienced in the Los Angeles area and give rise to irritation of the eyes and the respiratory tract. Coke ovens and other industrial plants are a source of excessive production of smoke and sulfur dioxide from the burning of coal. Considerable quantities of smoke are released into the air during the production of carbon black from natural gas or mineral oil and during the burning of waste oil residues near oil refineries. The potential carcinogenic properties of soot are well established and are supported by the occurrence of cancer of the skin in chimney sweeps. Apparently health hazards of various types exist for the population living in the immediate environment of other industrial establishments through air pollution with wastes.

Prolonged sterilization of the soil has been produced by deposition of arsenicals from smelter fumes or as insecticides. In a few instances such soil pollution by arsenic-containing industrial wastes has resulted in the contamination of the drinking water supply with toxic amounts of arsenicals. The extensive pollution of rivers and lakes with industrial wastes and urban unprocessed sewages has converted many bodies of public water into unwholesome cesspools, dangerous to any form of life dependent on them as normal environment or for water supply.

People are usually slow in reacting forcefully and effectively to gradually developing conditions injurious to health and survival. Some acute disaster is needed to arouse attention to such environmental health hazards and to force remedial action. The recent Donora disaster served in this role regarding industrial air pollution and brought about the realization, repeatedly voiced at the recent symposium on air pollution held at the Atlantic City meeting of the American Medical Association, that mankind has entered a new world of environmental conditions giving rise to new problems. Although acute mass disasters from environmental pollution by industrial wastes are spectacular events because of the number of deaths and diseased persons encountered, such catastrophes occur rather infrequently as the result of unusually massive exposures and are therefore of lesser importance than more widespread and less obvious injuries to health occasioned by the prolonged action of smaller concentrations of the environmental injurious agents on larger population groups. The type and degree of health hazards produced by such exposures are not readily ascertained. Often the symptoms produced are noncharacteristic and may be easily confused with those seen with bacterial infections, nonindustrial allergies or constitutional anomalies. Such insidious and often rather moderate effects on health are of distinct importance at times of more massive exposures, since they lower the resistance of the exposed persons to the higher doses and thereby lend with some more severe reactions than those that might be elicited in persons not preconditioned by previous contact with low doses of the injurious environmental agents. The extent to which such predisposing factors have been active may determine to a large degree the severity of the reactions and of the disaster seen with massive transitory exposures.


The maps include the following: Fog and sunshine, and the electricity grid. (FA)


Introductory remarks referred to physiological effects of gases and vapors on animals and plants, the effect of aerosols, and the contribution of fumes and mist to low visibility. Other papers dealt with smoke and fumes investigations, the legal regulation of air pollution, the Los Angeles smog problem, the nature of industrial dusts and fumes in Los Angeles County and on the development of air pollution standards, the measurement of visibility, the use of photographic photometry, the effects of fluorine in Tennessee soils and forage crops, the dispersion of waste stack gases in the atmosphere, etc., and several papers on collecting equipment. (APB)


Complaint is made about the fact that a governmental agency (the United States Public Health Service) is investigating the Donora, Pa., smog episode. It is suggested that private practitioners of medicine should engage in this study. (USPHS)


The need is pointed out for preventing air pollution, from the aspects of loss of material and of legal difficulties. A number of attacks on the problem by various organizations are recounted, and consultation with these organizations is recommended. The three solutions of air-pollution problems, namely, changing the process collecting or treating the offending substance, and adjusting operations to the weather, are considered with recommendations for equipment and methods. Cost factors are discussed. Seven " pointers on pollution" are put in the form of points to check and pitfalls to avoid in planning a control program; (1) Has every
chance to change processing methods to eliminate pollution before it starts been explored? (2) Is it certain that solving one pollution problem won't create another? (3) Has pollution been monitored for dispersion as waste after being collected? (4) In planning control measures, have possible future changes in control laws been considered? (5) Is work being done with the weather instead of against it? (6) Before signing a contract for pollution control equipment, have all the possible types been explored? and (7) Is full value being obtained in improved community relations from the measures taken? (IHD)


The natural pollution of air, by volcanoes, desert winds, etc., is compared with that made by man and an appreciation of their effects on population is given. The effects of topography and meteorological conditions on air pollution are also discussed. Pollutants could be prevented from escaping into the air, or provision could be made for the emission of smoke and soot to take advantage of weather conditions that would favor their dispersal. (AEP)


In addition to being the 26th report of the research committee of the Department this volume contains data collected during the 5 years ended March 31, 1944, and the report of the superintendent of observations thereon and also the usual report made by the Standing Conference to the Cooperating Bodies on their proceedings during that period.

Tables included that list the regions in which the observations were made, the mean rates of deposits, the trend of deposited matter, sulfur and sulfur dioxide measurements, and records of the smoke sulfur dioxide, and available daylight cycles.

The changes in atmospheric pollution during the war years are attributed to industrial changes, shift of population, local changes, military and civil defense operations, change of fuel and fuel economy. There were subsequent decreases for rain, chloride, sulfide, total dissolved matter, and smoky matter and increases in the deposition of other carbonaceous matter and ash. The noteworthy change was that at Dublin, where in 4 years the winter concentration of sulfur dioxide fell by 50 percent and the summer concentrations by 74 percent.


Clean air and water, and elimination of unsightly, smelly, or poisonous industrial wastes is basically a public relations problem. Delay in seeking a cure for business management's air- and water-pollution difficulties, and its avoidable by the community during the interim has generated a growing wave of resentment against industry. A good many plants that are now offenders were originally located in isolated areas that are now thickly populated.

Industry's two inadequate answers to complaints are: (1) It isn't so; (2) it's an industrial area—if people want to move into an industrial community they must be prepared to take the consequences.

The net effect of this is an antipollution movement, meetings, speeches, and letters to editors follow. Then the company seeks the advice of legal counsel; it resists to discuss the pollution problem perhaps even maintaining there is none. The reporter is likely to be barred at the gates. Then what started out to be a simple problem of dealing with a natural and proper community desire for better living conditions blows up into a holy crusade against the company. Finally some kind of pollution legislation is passed.

The time has come for all industry to face and discuss the pollution problem frankly.


Gives basic practical data on dust, its properties, formation, and methods of control. A diagram gives the rate of fall of particles of various sizes, the micron sizes being compared with United States standard screen sizes. (AEP)


In discussing some of the possibilities of removing smoke and dust suspensions by powerful sound and supersonic waves, it was stated that vibrations of 5,000 to 50,000 per second could be used to remove air-borne solids, and, while the most effective range for agglomeration was in the audible band (up to 18,000) the frequency could be so attenuated as to produce no objectionable noise. Analysis of the effect of supersonic sound, by passing the waves through glass tubes filled with smoke of various types, fogs of oil and water, quartz dust, and other common air pollutants, had shown that the containing particles formed "wafer" which were suspended in midair at intervals equal to half the wave-length of the sound, the relation for agglomeration varying from a few seconds to 10 or 15, depending upon the individual size and the concentration of the particles. A complex array of forces combined to drive individual particles together, the first theory to explain sonic agglomeration attributing the effect to the increased rate of collision resulting from the accelerated movement of the particles. Other forces similar to the phenomena which explained the trajectory curve of a baseball were also involved. (FA)


Reference is made to the Donora air-pollution disaster, in which 21 persons died, the Los Angeles smog causing eye irritation to the inhabitants, and the pollution of the air with smoke and fumes in St. Louis, which necessitated turning on the street lights at 3 a.m. These examples emphasize dramatically the need for an effective program to prevent atmospheric pollution.

Atmospheric pollution may be divided into two general categories: The smoke problem, caused by the emission of dense smoke and its by-products; and the smog problem, caused by the emission of industrial fumes and gases, noxious acids, and other contaminants that hang close to the ground and do not dissipate in the air.

Smoke control ordinances may be divided into two general classifications: Punitive ordinances and ordinances seeking to prevent smoke pollution by preventing the creation of smoke.

Legal validity of ordinances is not enough; it must also be workable and enforceable. The basic provisions of the ordinances that seek to prevent the creation of smoke are discussed briefly.

In most respects a smoke ordinance is similar to a smoke ordinance. The difference between them is in
the prohibitory section and in the rules issued by the
enforcing agency to supplement the ordinance. Three
factors are mentioned in connection with the pro-
hibitory section of a smog ordinance—persons to be
included, contaminants to be prohibited, and standards
to be adopted.

Equipped with an ordinance of the type described,
a city is likely to attack its air-pollution problem.

195. STOKINER, H. E. Air Pollution and the Particle-
60-62.

The first section of the paper is devoted to general
problems of industrial air pollution, both in the plant
and in the community. The findings regarding the
Donora disaster and the smog situation at Los Angeles
are reviewed. The specific fields of poisoning by beryl-
lium and by toxic materials used in the uranium indus-
try are then considered. The cases of beryllium
poisoning at a distance from a plant, mentioned in the
literature, led to the discovery that beryllium is toxic
in exceedingly small amounts. Turning to in-plant
problems, it has been shown that the toxicity of beryl-
lium dust is directly related to its surface area, whether
surface area itself is responsible or some related prop-
cie, such as wettability or electric charge. Toxic ex-
posures to beryllium mist may exist where the beryllium
is dissolved in sulfuric acid. This brings up the sub-
ject of mixed exposures, about which very little is
known.

Hydrochloric acid, in concentrations harmful to
themselves, has been found to double the toxicity of
beryllium. Exercise increases susceptibility. Tubercu-
losis and beryllium poisoning have no effect on each
other’s course. Uranium poisoning is discussed more
brieferly, with discussion of the toxic effects of soluble
and insoluble compounds. The maximum allowable
concentration has been tentatively set at 50 micrograms
of uranium per cubic meter of air for soluble com-
ounds purely on a chemical toxicity basis of renal
injury. The injurious radiative effect would require
much higher exposures than are encountered in prac-
tice. (HID)

196. SWAIN, ROBERT E. Smoke and Fume Investigations.

In a historical survey of atmospheric pollution, early
investigations in England and Germany are cited. The
subject was a live one, not only in laboratory and
field studies but in legislative halls as well.

Outstanding instances of injury to animal and plant
life by emanations from industrial plants, such as at
Ducktown, Tenn., Anaconda, Mont., Salt Lake City,
Utah, and Trail, B. C., are discussed in detail. The
steps that have been taken to prevent and control such
conditions are outlined. Investigations at Ducktown
revealed that widespread injury was beyond dispute.
Out of this situation came the great industrial achieve-
ments of the conversion of the offending sulfur dioxide
from copper-smelting operations to sulfuric acid. At
one time the income from sulfuric acid produced by
these smelters, once thrown away, took first place and
copper took the place of a by-product.

With the installation at the Anaconda smelter of an
enormous Cottrell system for electrical precipitation,
one of the most remarkable instances of injury to live
stock by smelter smoke ever recorded passed into
history.

At Salt Lake City certain injury to plant and animal
life was stopped by a court stipulation that required
each plant to discharge its gases through a stack 450
feet in height; to give buoyancy to escaping gases by
maintaining throughout the growing season, between
surprise and suddenness, a differential temperature of at
least 75° C. between the stack gases and the outside
air; to subject all emissions from smelting operations
to electrical precipitations by the Cottrell process.

The Trail, B. C., case became an international prob-
lem and led to a convention between the Governments
of the United States and Canada. Damages in the
amount of $78,000 were awarded. The international
tribunal laid down a regime of operation that involved
a regulation of the amount of sulfur dioxide issuing
from furnaces, in accordance with certain conditions
of wind direction, and velocity, atmospheric turbu-
ience, time of day or night, and the readings of a
Thomas sulfur dioxide recorder, recording continuously
at a central control office. From this office go orders
to shut down or resume operations depending on specific
stipulations of the regime.

About $13,000 was finally invested in recovering air-
borne wastes and converting them to marketable by-
products. The program has functioned successfully.

In all the instances mentioned a successful solution
of the local issue to the smoke problem was found, and
all turned out to be profitable business investments.
(18 refs. are cited.)

197. TOWNSEND, J. G. Dr. Townsend Speaks in West
Virginia on Atmospheric Pollution. Ind. Hyg. News-

Mention is made that atmospheric pollution embodies
two concepts. One is smoke and the other is dusts,
smokes, fumes, vapors, mists, and other contaminants. The
smoke aspect was recognized first.

Reference is made to the Los Angeles smog problem
and other air-pollution studies.

Various methods of solving the problem of air pol-
ution are discussed. Plants contemplating new con-
struction are being designed to control contaminants,
just as safety features have been built into machinery.
The type of control depends on the nature of the
contaminant.

Morale as well as health may be affected adversely
by air pollution.

198. WEST VIRGINIA PUBLIC HEALTH ASSOCIATION. Pro-
cedings of 25th Annual State Health Conference,
vol. 13, 1949.

The history of the investigation of air pollution was
related and air contaminants, their effects, and possible
preventive measures were discussed and the sources of
various types of contamination and the effects of
weather were considered. (APB)

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199. ARCHIVES OF INDUSTRIAL HYGIENE AND OCCU-
PATIONAL MEDICINE. 9th Annual Conference.
Industrial Health; Report of the Panel on Environmen-

The panel included a planning committee and six
affiliated committees, each of which presented a report.

(1) Committee on Atmospheric Pollution. This
report was necessarily preliminary and general.

(2) Committee on Chemical Agents. The discussion of
maximum allowable concentrations was extensive.
It is summarized as follows: The committee’s discus-
sions were directed to two subjects. The subject of
hygienic standards, often known as permissible limits,
was critically analyzed, and several improvements in
present tables were recommended. Standards applica-
tible to three forms of exposure not covered by current
tables are badly needed. Further work on biochemical
tests to evaluate exposure and physiologic tests to
measure early response is urgently needed. Consider-
eation of new chemicals in commerce resulted in the
conclusion that the producer is obligated to communi-
cate a reasonable knowledge of their hazards. Facili-
ties for obtaining this knowledge must be increased,
and toxicologists must be trained. New agents in
agriculture are particularly important, and the indus-
trial hygienist should devote more time to this major
industry.
A BIBLIOGRAPHY

(5) Committee on Physical Agents. A large part of this report consists of tables wherein the various physical agents are classified as to: (a) Definition and origin; (b) occupational source and number of persons involved; (c) effect on health; (d) evaluation; (e) control; (f) therapy; and (g) need for further action or study.

(4) Committee on Biological Agents. This subject has a number of ramifications that were considered, including acute infections of the respiratory tract; vaccination of industrial workers; dust as a carrier of infection; tuberculosis; infectious agents in agriculture, transportation, and mining; and relation of environment to cancer.

(5) Committee on Education and Application. The three general subjects considered were scope of industrial hygiene, education and training, and application and research.

(6) Committee on Administrative Practices. The committee recommends better types of legislation, uniform concepts of procedures and standards, and training for better leadership. Many details of these reports are profitable reading. (IHD)


Atmospheric pollution in Chicago is described, and the work done by the public and by industry toward the abatement of pollution is reported. Costs to the city and to industry are discussed. New equipment and techniques which are inexpensive, practical, or even profitable must be devised. Here is another opportunity for research. (AIHOM)


Some 30 air-pollution and smoke-regulation officials from Ohio, Michigan, Indiana, Kentucky, and Pennsylvania, meeting in Columbus last week, formed district 1 of the newly created Air Pollution and Smoke Prevention Association of America.

Hosts of the group were Battelle Memorial Institute and the City Division of Smoke Regulation. Antismoke officials from North Carolina attended as observers, preparatory to forming a district of the new association.


A general discussion is presented of the problem as it relates to health. The need for more research work in the field is stressed, and the importance of public opinion in any campaign to control air pollution is emphasized. (USPHS)


The Donora smog episode and other recent events have jet-propelled the industrial hygienist into the field of air pollution. Prompted by the Donora proof that air pollution does have health implications, over 30 States and cities in the last year have asked the Public Health Service for assistance in evaluating and controlling local air-pollution problems.

The air-pollution question is caught in a pincher's movement of agitation. The two claws of the pinchers are an intensified concern with the nuisance aspect of the air-pollution problem and consideration of its health implications. While the public and professional interest is at a high pitch is the time for action. Industrial hygienists must respond to the public need and demand for a cleaner atmosphere. Suggestions are given for participation in an effective program for the reduction of air pollution.


Atmospheric pollutants consist primarily of (1) smoke and particulate matter resulting from incomplete combustion of fuels and (2) fumes, mists, gases, and dusts produced by industrial operations. Illustrative data are presented showing soilfall and concentration of gaseous contaminants in several industrial areas in the United States. Meteorology and topography are related to concentrations of airborne contaminants.

The effects of air pollution are discussed under five main headings: nuisance, economics, health, vegetation, and animals.

Control methods pointed out include substitution, conversion, retention, and dispersion, with emphasis on the latter two.

Need for proper selection of and further research on commercial air cleaners and the necessity for competent legal handling of pollution problems are discussed. (35 refs. are cited.) (AIHOM)


Atmospheric pollution in England in general and the steps taken to reduce it are discussed. Among the subjects considered are: Grit as an air pollutant and its collection; source and effect of hygroscopic nuclei; effect of weather conditions; formation of sulfuric acid; and use of pulverized fuel ash. (IHD)


Among Canada's chief sources of atmospheric pollution are the smelters at Trail, B. C., in the Columbia River Valley, and in the Sudbury region of Ontario. Reports on both regions are summarized, indicating the progress made. Automatic recordings of sulfur dioxide concentration were made regularly at a number of points in the Columbia Valley from 1957-40, and are still being made at three points south of Trail. Remedial measures by the smelting company have resulted in reducing the amount of sulfur dioxide involved and eliminated all damage south of the international boundary. In the Sudbury region, ground studies of sulfur dioxide in the air and in vegetation were supplemented by measurements at varying heights and distances by means of portable equipment on an airplane in flight. All these data will be correlated with meteorological studies and with biological investigations to delimit the zone of smoke damage and arrive at a satisfactory solution of the problem. (IHD)


Smog means different things to many people. To people in Los Angeles it is associated with smarting eyes. To Chicagoans it means a sky murkiness at midday. Many people judge smog in relation to their soiled clothing and dusty furniture.

As a slang term, smog has a broad meaning. While it usually results from abnormal weather conditions, it is due to the fumes, gases, factory wastes, and particles that float about in the local atmosphere and to smoke and other products of combustion.

As a starting point for year-round smoke abatement and air-pollution control by publicly, industrially, and civic bodies, October 22 to 28 has been designated as National Smoke Abatement Week. Sponsored by the Air Pollution and Smoke Prevention Association of America in cooperation with other groups, including the United States Chamber of Commerce and the National Coal Association, National Smoke Abatement
Week has been endorsed by the Secretary of Commerce. Its main purpose—to focus attention upon the need for action—is reflected in the slogan, "Stop All Air Pollution."


Industrial hygiene has moved outside the plant walls and begun to be concerned with industrial health hazards to the individuals in the community around the plant as well as to the workers in the plant. In other words, the industrial hygienist has joined the chemist, the chemical engineer, and the meteorologist in considering the problems of smog and air pollution.

This acknowledgment of expanded responsibility was abundantly apparent in the annual meeting of the American Industrial Hygiene Association held in conjunction with meetings of five other associations concerned with the physical well-being of industrial workers. Although only a small number of papers on the 4-day technical program were devoted specifically to air-pollution problems, the preponderance of corridor and taproom conversation was devoted to this area of activity.

The growing cooperation between industry and local government was emphasized, and the cooperative technique used in the city of Baltimore was described. Under this arrangement all applications and plans for industrial construction or expansion are referred to the bureau of Industrial Hygiene for review. Any source of possible pollution suggested in this review is then discussed with the industry representatives. If it is decided that the possibility of pollution is serious, the industry has the benefit of the technical knowledge of the civic specialists in the field of pollution control. Since experimental work on effluent control may run as much as 10 percent of plant-installation cost, the availability of these specialists can effect a substantial monetary saving for industry. This procedure has worked well in Baltimore, and in most instances a true cooperative effort resulted. It is recommended that other cities adopt this approach rather than the purely punitive attitude sometimes found in the past.


The Smoke Prevention Association of America recently reorganized, adopted new bylaws, and changed its name to Air Pollution and Smoke Prevention Association of America at a meeting in Montreal.


Coal has been used in England for heating purposes for at least 1,000 years, and as early as the 13th century there were serious complaints about pollution of the atmosphere by the burning of coal. The old adage about carrying coals to Newcastle was almost reversed in 1648, when Londoners sought authority from Parliament to prohibit the import of coal from the northern cities.

There has, of course, been a rapid rise in the use of coal in the last 2 or 3 centuries, coincident with the increase in population. In 1700, for example, when the population was between 6 and 7 million, the output of coal was roughly 3,000,000 tons. By 1900, with population in the British Isles some 37,000,000, coal consumption rose to 220,000,000, and in 1913 the record figure of 287,000,000 tons was reached. During the last 20 years the rate has been between 170 and 190 million tons.

Select parliamentary committees to inquire into the nuisance caused by smoke and pollution of the atmosphere were set up as far back as 1819, and the report on the most recent one was issued in 1946. Legislation has also been enacted from time to time with the object of solving the problem, but legislation without the assistance of practical methods is inadequate to insure freedom from smoke and grit in the air.

The total solid matter deposited in cities and towns of England varies between 50 and 2,000 tons per square mile each year, with an average of about 400 tons for an industrial area. Country districts may receive as little as 10 tons per square mile.

Although the problem of eliminating smoke, soot, and grit is difficult, reduction in atmospheric pollution is possible by the proper cleaning of coal and by insuring that coal and its products are used with the maximum efficiency. In the latter connection, modern solid-fuel burning appliances have recently been greatly improved, and the National Coal Board is making efforts to raise the standard of its cleaning plants.


A commentary on a report published by the Department of Scientific and Industrial Research on atmospheric pollution observations between 1939 and 1944 quotes examples of long series observations and considers the factors involved. It is concluded that there was no marked and general increase of atmospheric pollution during the war period, but there is need for great improvement. Methods of reducing pollution are commented on. (APB)


The general increase and concentration of industry in recent years have intensified air-pollution problems. People are interested only in the effects of pollution and are convinced that the air in industrial areas is pathogenic, though indications of this are lacking. Certain pollutants may constitute a health hazard; others that are a nuisance, such as odors, may affect the well-being of people and thereby influence their health. Elimination of the latter may not be necessary, but a reasonable attempt to control them should be made. Material damage of property and vegetation may be caused, and also the socialologic implications of clean air are important in all housing areas when the whole community is being considered.

Much work has been done to control the products of incomplete combustion of fuels, but the emission of industrial processes are a far more difficult problem, the cost of control often being prohibitive. If the pollution is a health hazard, drastic steps must be taken; but if it is only a nuisance, consideration must be given to the community's need of the economic support afforded by the plant involved and to that plant's inherent right to reasonable operation. If legislation is found necessary it should stipulate only the performance required, free choice of method being allowed. This control should be handled by each community; it should take two forms, the first, dealing with each plant in turn, to reduce the pollution in small areas; the second, a long-range proposition to control the air for the whole community. It may be necessary for a community to have its own staff, under an industrial hygiene engineer, to effect control, and consultants may be available at a State agency.

There is great need for research respecting long exposures to low intensities of contaminant and the effects on the very young, the aged, the hypersensitive, and the ailing; meanwhile the control officer must use all the information that is available at present.

Finally, education and good public relations must be given consideration; management is becoming more cooperative in fact finding, ready to admit offenses, and to spend large quantities of money to improve conditions. Many affected communities are spending large sums to reach a point where both the community and the industry can exist comfortably together.
AIR POLLUTION—A BIBLIOGRAPHY

213. Eyt, S. B. Report on Stationary Stacks, 1949. Pittsburgh Dept. of Public Health, Bureau of Smoke Prevention. 1950. A report on air pollution in Pittsburgh in 1949 and on the work of the Bureau of Smoke Prevention in decreasing it is presented. It includes reports on dustfall records, dust analysis, "smoke observations" or visibility measurements, the work of the Bureau in controlling illegal coal and enforcing the law's other provisions, and comments from aviators on the great improvement in visibility above Pittsburgh. Estimates by various methods indicate 40 to 75 percent reduction in dust in the city. Dustfall records show a reduction of 70.0 to 61.6 tons per square mile over downtown Pittsburgh and reductions at nearly all the other points where measurements were taken. This dust naturally comes from other sources besides smoke. About 60 percent of its composition is silica, iron oxide, zinc oxide, and sulfur trioxide. The amount of smoke as judged by visibility increased slightly from 1948-49, with a steady loss from 1945-48, but the smoke during the heating season decreased constantly. Statistics on complaints, cases tried, and improvements in private stacks are included. (IHD)


The usually accepted definition is given of ventilation as supplying air to and removing air from an enclosure. Also if those engaged in abating atmospheric pollution have done their job and maintained a nice, clean atmosphere outside, the ventilation job of bringing in outside air is simplified. Even on days when the temperature outside may be perfect to do a ventilating job, only the minimum of air that is required is brought in because air has to be cleared before it can be distributed around the building.


The following amusing reference is made to the London fogs said to have been prevalent a half a century or more ago. The late Hieronymus Karl Friedrich, Baron Münchausen, of whose truthfulness and integrity there can be no manner of doubt whatever, recorded how, on a visit to these shores, he found the fog in London so thick that he cut himself a cube of it to take home to Germany. Those who remember the "pea-soupers" of half a century or more ago may well affect to believe that his memory suffered on that occasion from some slight lapse. It is probable, our ancestors tell us, that the Baron must have been in an outlying district, for the fog was less dense than at the center, for had he essayed to cut himself a cube of it there, it is most unlikely that he would ever have found his cube again. Another school of thought denies that the fogs of those days were soft enough to cut without a hackaw, a tool then not yet invented. The fogs of 1850 are but faint wisps of those generated by our grandmothers, but we are more acutely conscious of the harm that they do to buildings and personal health.

The valuable work done by the National Smoke Abatement Society is cited, although there is a great deal yet to be done. Reference is made to the material help rendered by the gas and electricity industries in reducing the emission of smoke in industry.

Although the problem of industrial smoke probably will solve itself through the conscious efforts of fuel technologists urged by pressure of public opinion, there remains the exceedingly difficult problem of domestic smoke. The only real solution here is that applied in America, namely to forbid, under local ordinance, merchants from selling fuel containing more than a defined modest content of volatile matter. If the volatile matter content could be limited to 12 or 15 percent the domestic smoke would be much less.


This is an illustrated article, written in popular vein, describing the "acid, yellow-gray pall that blots out the sun, produces swollen eyes, rasping throats, asthmatics attacks and some of the rawest tempers west of the Mississippi." The attitude of the residents, the causes of smog, and what has been accomplished in its control are discussed. As in Donora, the chemicals causing the irritation have yet to be isolated and dealt with.


The Fuels Division of the American Society of Mechanical Engineers sponsored a symposium November 30, 1949, at the annual meeting of the society devoted to the utilization of fly ash. It is used in bituminous road construction, insulation, brickmaking, soil stabilization, and molding. (IHD)


During the 1949 operating season, the Bureau of Industrial Hygiene of the Baltimore City Health Department studied seven Baltimore plants that manufacture asphalt paving materials. The purpose of the study was to evaluate the effectiveness of dust-suppression methods installed at the beginning of the year, when an accelerated production schedule was instituted. One of the major objectives was to alleviate pollution of the atmosphere with dust.

The extent of the contamination of the atmosphere found outside the seven paving plants under study is unlikely to be detrimental to health, but it may cause discomfort. The nuisance character of the finely dispersed material results largely in property damage and irrate neighbors. The degree of the nuisance and attending complaints is dependent upon: (1) Efficiency of the dust-collecting equipment; (2) population density of the neighborhood surrounding the plant (high, medium, and sparse classification); (3) physical properties of the materials processed. These factors together with the cost of dust collection were evaluated.

Comparison was made of the experience with and performance of wet and dry centrifugal collectors and a water and steam scrubbing collector.

To avoid a repetition of the prevalence of complaints from handling finely divided materials, those plants in areas of high population density should install a commercial wet-type dust collector, and even the plants in areas of medium population density should consider the installation of such equipment.


The formation of an Air Pollution Committee to advise on research on this problem has been announced by the Industrial Hygiene Foundation at Mellon Institute, Pittsburgh. Organization of the committee was recently authorized by the foundation's board of trustees.


The proceedings of the United States Technical Conference on Air Pollution, held in Washington, D. C., on May 3-5, 1950, are reviewed.

The findings of the seven panels on agriculture, analytical properties and methods, equipment, health, instrumentation, legislation, and meteorology are summarized briefly.

The various air pollutants are discussed and classified. Innoxious gases and vapors may be converted to obnoxious compounds by reaction with other contaminants in the presence of sunlight or by reaction with the oxygen of the air.

Meteorological and topographical conditions to a large extent control the degree of pollution from domestic and industrial sources.

Discuss sources of the principal gases and vapors, prevalence, and means of removal.


Comprehensive knowledge of the source, nature, and extent of atmospheric contamination is necessary before effective control measures can be instituted in a given area. These complex factors must be evaluated by investigations along physical, chemical, biological, and meteorological lines. The mass rate of emission of objectionable effluents from each major source should be known, as well as the maximum and average ground concentrations of aerosols and gases at a sufficient number of test stations. The meteorological studies should include data, not only on surface winds, but on the movement of upper-air currents, lapse rates, and turbulence as well. Frequently, advantage can be taken of the fact that, in many areas, upper-air currents move in the opposite direction to surface winds and are more effective in dispersing smoke. Biological investigations of the effects of pollution on plant and animal life may reveal the limits of penetration of appreciable contamination. The Trail Smelter investigation is one of the outstanding examples of the application of data from all these lines of approach to a successful solution of a pollution problem.

Such measures improved conditions but did not eliminate the pollution problem until extensive remedial works were undertaken to reduce the mass rate of emission of sulfur dioxide. These recovery plants now form the basis of a large heavy chemical industry and involve the following processes: (a) Concentration of sulfur dioxide, (b) production of sulfuric acid, (c) nitrogen fixation and production of ammonia, the necessary hydrogen being produced by electrolysis of alkaline water, (d) phosphoric acid production, (e) production of phosphate, ammonium sulfate, and ammonium phosphate-sulfate fertilizers. The production of elemental sulfur by reduction of sulfur dioxide with coke has also been undertaken at various times. The total sulfur-recovery capacity in 1940 was about 600 tons of sulfuric acid, and 140 tons of elemental sulfur per day.


This bibliography contains 240 annotated references to works published between 1861 and 1949 (arranged chronologically and outlined by subject and geographical location) on air sampling and analysis instruments and methods; effect of atmospheric pollution on animals, building materials, public health, vegetation, etc.; mechanics of dispersion of particles in the air; smoke-abatement measures and other aspects of air pollution in relation to meteorological factors in all parts of the earth. (AIHOM)


The work of the Coal Producers Committee for Smoke Abatement is described. It consists of surveys, con-sultations on air pollution problems, and recommendations for abatement. It is emphasized that solutions of the problems of large cities may differ greatly, according to local conditions. Eight points included in a sensible approach to the air-pollution problem are (1) facts, not hearsay; (2) attention to engineering, equipment, and education; (3) consideration of economic factors; (4) emphasis on administrators rather than on legislation; (5) acceptable standards; (6) differentiation between nuisance pollution and health factors; (7) public support; (8) cooperation of experts in all fields. (AIHOM)


Atmospheric pollution prevails in varying extent in every city of any size. According to the American Municipal Association, only four American cities of over 25,000 population have not established some sort of air-pollution control. This has evolved as smoke abatement, but today enlightened opinion realizes that smoke, being visible, receives too much blame in popular misconception and that smoke is only a part—and a largely controllable part—of the broader vexation of smoke.

Up to $100,000,000 is being spent annually in the United States by industry and municipalities to combat air pollution. There is more scientific study underway in this phase of public hygiene than ever before, but much more research is needed and more is indicated. American cities get pure drinking water, pure milk, sewage disposal, fire and police protection because these are recognized as civilized necessities which the taxpayers will pay for. We should have this kind of public support for air-pollution control.

The occurrence of fumes, gases, and dusts in the atmosphere and what can be done about them are discussed.


Comparison indicates no direct relation between atmospheric dust pollution and deaths from respiratory diseases in Dublin. During the war years when peat replaced coal for home heating, atmospheric pollution was considerably reduced. (APR)


Brief preliminary report on the study of air pollution made in Los Angeles. The gaseous contaminants accurately measured include sulfur dioxide and tri-oxide, ammonia, aldehydes, and (maximum only) oxides of nitrogen and filterable oil. A number of other contaminants are known to exist, and six others are found occasionally. The five types of particles include: (1) Carbon and metal particles; (2) transparent, light-scattering crystals; (3) small water-soluble and oil-soluble particles and oil droplets; (4) substances capable of forming moisture droplets in the air; (5) large, soluble crystals. Types 1, 2, 4, and 5, in varying degree, account for most of the lack of visibility. Tests show that no one contaminant is responsible for irritation of the eyes; it apparently results from a number working together. (AIHOM)


Brief summary of the subjects of the panel discussions scheduled to be presented on health, meteorology, instrumentation, equipment, analytical methods and properties, agriculture, and legislation at the United States Conference on Air Pollution to be held in Washington, D. C., May 3, 4, and 5. (5 refs. cited)
AIR POLLUTION—A BIBLIOGRAPHY

The summaries and recommendations of the panels on agriculture, meteorology, health, and legislation of the Air-Pollution Conference are reported by the panel chairmen.

This was the keynote address at the Air Pollution Institute at the University of Michigan, February 6, 7, and 8, 1950.
The unwanted effects of polluted air fall into two overlapping categories—economic, damage to material properties, and physiologic, damage to human and lower animal life forms. Comments deal mostly with the second category.
Proper physiologic appraisals require such data on air pollution as pollution by what, how much, how long, how determined, what sizes of particles, who is exposed, what are the conditions of exposure. Referring to early English panic and riots, and laws, over air pollution it is suggested that if capital punishment may be reviewed for early coal users, and enforcement secured, the chief labor of the audience shall have been accomplished and it could adjourn promptly.
Mention is made that potential little Donoras are common throughout certain areas. Medicine in relation to air pollution finds its greatest handicap in the inability to appraise the long-range malignance of low levels of toxic substances.
Fixed standards for concentration of gases, vapors, dusts, and fumes are called futile. Biologic responses do not lend themselves to exactness in relation to the action of harmful agents. In this formative period of increased activity in air pollution it would be most unfortunate to demand or formulate inflexible standards of exposure.

November 12–18 was set aside as Smoke-Control Week in New York City as a follow-up to National Smoke-Abatement Week, which began October 22 under the slogan “Stop all air pollution.” Representatives of 25 civic groups decided upon that period at a meeting called by the director of the Bureau of Smoke Control, to discuss ways of acquainting the public with the city’s new smoke-control rules and regulations, which went into effect on October 1.
The campaign stressed the “necessity of smoke control from an economic, health, and safety point of view by means of talks, movies, store-window displays, newspaper releases, and posters.” The talks were delivered “in layman’s language” to assure that everyone responsible for dwellings and establishments that emit smoke has a thorough knowledge of what the rules demand and how they can be complied with.

In asking Congress for $250,000 to enable it to conduct air-pollution studies in five areas, the United States Public Health Service has pointed to the conditions in the Staten Island (N.Y.) area as the most urgent, the result of gaseous, smoke, and fumes that have swept in from industrial plants in and around Carteret, N.J.
The Service has received requests for investigation of the complaints from the State health departments of both New York and New Jersey and has made plans, upon the recommendation of its industrial hygiene advisory committee, first to enter into research which will evaluate the harmfulness of the air, then to work out cooperative techniques for meeting industrial health needs of small plants, and finally to institute a local-State-Federal system of recording occurrences of occupational diseases and the success of medical-care programs on the part of industry.

Some of the greatest advances in the science of aerosols were made during the recent war, when problems on the formation and behavior of smoke clouds, analysis, assessment of particle size, protection against toxic agents, and the dispersal of insecticides had important military implications. Much of the research work was done under the auspices of the National Defense Committee.
After the war, a technical report was prepared by division 10, summarizing the information that had been gathered for the use of the military agencies as a guide for further research. At the request of the Atomic Energy Commission, portions of this report have now been declassified and are being published by the Commission so that the methods developed may find their greatest use. It is gratifying to know that this work, which occupied the attention of many men for several years, will now be available to all scientists.
In a field of science that has been as active as this, there have, of course, been many developments, even in the few years since the war, especially in the aspects related to air pollution. The reader will find that this volume contains basic discussions and descriptions of theoretical and experimental importance in the field of aerosols.
The following subjects are discussed: The adsorption of general meteorological principles, micrometeorological instruments, general properties of aerosols, stability of aerosols and behavior of aerosol particles, formation of aerosols, optical properties of aerosols, measurement of particle size and size distribution, filtration of aerosols, methods of testing smoke filters, and travel and persistence of aerosol clouds.

An attempt is made to confine the entries to the branch of geophysical science that deals with the atmosphere and its boundaries. Material has been limited to not limited to that appearing in current periodicals but will embrace communications of any form or type transmitted by any means or medium.
As a rule, the material that is best known to American meteorologists is given the least space. The important material that would be difficult or expensive for most readers to obtain will be described in detail to help the reader to evaluate better the work in connection with his own needs and limitations as to time and funds for obtaining photo or microprints.

Division of Industrial Hygiene and Safety, New York State Department of Labor, surveyed chemical plants to determine effluents given off and advise whether school children would be safe at prospective school locations nearby. Careful studies were made of plant operations, chemical processes, and ventilation. Meteorological data were obtained as to prevailing wind direction in the area. The problem of air pollution was discussed with plant management and school authorities. It was agreed that the discharge of all contaminants into the surrounding atmosphere could and would be properly controlled.

The first Government-sponsored conference of its kind was held in Washington, D. C., May 3, 4, and 5. The conference was sponsored by an Interdepartmental Government Committee, including the Bureau of Mines, U. S. Department of the Interior; Public Health Service, Federal Security Agency; United States Weather Bureau and National Bureau of Standards; U. S. Department of Commerce; Army Chemical Corps, Office of the Surgeon General, United States Army; Office of the Surgeon General, USAF; Bureau of Medicine and Surgery, United States Navy; Research and Development Board, Defense Department; Atomic Energy Commission; and the U. S. Department of Agriculture.


The members of the Air-Pollution Institute (held at the University of Michigan, February 6, 7, and 8, 1950) were reminded that air pollution was a tangible reality long before the advent of civilization. Down through the ages from caveman to atom buster, the air has contained foreign substances, some of which have been helpful, others inimical to man’s health.

It was suggested that the experts and specialists forming the conference would crystallize their thinking and concept of what can be done to minimize harmful air pollution would be jelled.

1951


Harmful physiological effects upon man, animals, and vegetation, both actual and potential, have caused many specific complaints; they are largely responsible for the general increasing concern and agitation about air pollution. It is the purpose of this section to promote understanding of the air-pollution problem by (a) describing the nature and significance of the varied effects which are possible, (b) indicating the nature and extent of the difficulties which have been experienced, (c) outlining the requirements for adequately establishing a causal relationship between pollution and physiological effect, (d) indicating physiological methods and information useful in handling problems. This summary relies on a series of recent review papers for most of the information dealing directly with atmospheric air pollution. Other information has been obtained from publications located through the last 20 volumes of Chemical Abstracts and also from the somewhat dispersed toxicological literature. (89 refs. cited)


A column a week is published by Hamilton spectator on the evils of air pollution. The column entitled “Smoye” is prepared by John O’Hanley, chief smoke inspector of Hamilton, and published by the newspaper as a public service to the whole community.

Drawing the attention of the residents of Hamilton to air-pollution problems brought results. A new department—the Smoke Abatement Division in the Building Commissioner’s office—was organized to administer a smoke-abatement program and enforce the smoke-abatement law.


The proceedings of a 2-day meeting of the eastern central section of the Air Pollution and Smoke Prevention Association of America, held in Detroit September 13-14, 1951, are outlined briefly. Means of reducing smoke in various industries were discussed.


A discussion brought out that the practical limits of an area-wide study would be centered around a metropolitan area, and many cross city and county lines in the same degree that meteorological areas cross those lines.

Air pollution from neighboring metropolitan areas in the order of 20 or 25 miles distant, or heavy point sources, such as forest fires hundreds of miles away, affect pollution over a city, but it would be difficult to determine such effects, and then, having determined the effects, control of such distant sources would not be feasible. Therefore, practical, should be confined to the metropolitan area.


Experiences in connection with work as smoke inspector for the Pennsylvania Railroad are described. Some experiences are humorous and entertaining. It is believed that they will also be of educational value to the beginner in the type of work, as well as to the experienced inspector.


A Los Angeles correspondent for a San Francisco newspaper wrote the following report over 80 years ago: “It is now about 6 days that we have in this and the surrounding country been the spectators of an unusual phenomenon, which, from its peculiarity, has given occasion to manifold surmises, conjectures, speculations, and rumors. The atmosphere has been so filled with smoke as to confine the vision within a small circumference. And as the smoke was wanting in those aerial properties which affect the eyes and nostrils, there were not wanting many who denied the assertion that it was smoke.”


Some of the air-pollution problems confronting industry are described and suggestions given for improving conditions. The elements that contribute to air pollution in different localities are discussed in detail. (APB)


Public sentiment against industrial air pollution has reached the point where the expense involved in preventing such pollution must be considered by the process-plant owner as the price that society demands of him for permission to operate his plant.

More restrictive local ordinances and increasing publicity are evidence of the mounting awareness of air pollution on the part of the American public.

Managers of process industries should also consider whether their products contribute to air pollution in the hands of their customers. For instance, automobiles and trucks contribute largely to air pollution in our cities with exhausts fouled by smoke, carbon monoxide, and other gases, often due to improper engine adjustment. Engine builders should study the problem of complete combustion under all operating conditions; or, if this is impossible, of developing a catalyst to oxidize the carbon monoxide in the exhaust gases on which problem some work has already been done.

Both ordinance administrators and plant operators are handicapped by the lack of simple standards to measure air pollutants. The Ringlemann chart used for smoke measurement has many faults and is little
good on dust or gaseous discharges. Visibility alone is an uncertain standard. The American Society of Mechanical Engineers code on smoke measurement involves a lengthy test. Meters based on light intensity through a gas column have merit for smoke or dust measurement. At present there are no standards for gases and odors and no simple means of measuring their amounts. Much development of standards remains to be done.

The trend of public sentiment is that process industries must take steps to stop their contributions to air pollution. If this is not done voluntarily, legislation will force compliance with regulations or close up offending process plants.


All members of the industry have been confronted with enough evidence to realize the seriousness of air pollution.

Although only a few places have experienced disastrous effects from air pollution, Canadian industry also has felt the effects of air pollution and, in view of the great industrial expansion, now is a good time to adopt anti-pollution measures.

Reference is made to the introduction into the legislatures of 12 States of 33 measures for regulating air pollution. Although many of the 33 measures were routine, some revealed a trend that the chemical industry in Canada would be wise to anticipate and defeat.

A bill was introduced in Massachusetts that would have forbidden operation of any business enterprise that emitted any odor that could be smelled within 300 feet of the premises.

It is doubtful that legislation can achieve any possible relief that cannot be attained, much more cheaply, and painlessly, by industry—if it acts voluntarily.

Standard Oil Co. of New Jersey spent $10,000,000 during the past 4 years combating air pollution. Dow Chemical Co. spent $3,000,000 in 1 year. Of 75 companies replying to a query in the United States, 50 reported having spent 35 million anti-air-and-water-pollution dollars in 2 years.

An expenditure of the chemical industry’s energy and resources, in direct proportion to the increasing potential seriousness of the problem, should see the industry emerge with its good name intact.


The results are given of a study of the air-pollution load in the Cleveland area, with the steel industry in operation and while the steel industry was closed by a strike. The plan of survey and sampling procedures are discussed.

Concentrations of sulfur dioxide and fluoride did not seem to be much affected by the absence or presence of the steelmaking activities. However, such activities had an appreciable effect on the soiling value of the air-borne dust. The emissions of iron oxide and carbonaceous matter no doubt made a substantial contribution to the soiling effect.


The form and details of a proposed ordinance concerning atmospheric pollution in Canada are set out and definitions are given for the various terms used. Types of emission and processes involving such emissions are discussed. (APB)


Industrial-hygiene agencies in increasing numbers are establishing programs for study of community air pollution from industrial processes. Such a program in Detroit is conducted jointly by the Industrial Hygiene Division of the United States Public Health Service and the Detroit Department of Health. The Detroit program consists in part of evaluating plant processes, stack effluents, and community air contaminants. Approximately 50 field stations and 2 mobile laboratories are utilized, locations of which are based on such factors as population density, meteorology, and topography. With minimum additional personnel and equipment, this program would materially assist in the civil-defense program. Industries where large quantities of poisonous materials are used should be mapped and cataloged, showing types and amounts of poisonous materials used, relation of resistance to these plants, determination of areas of potential contamination and official restriction of poisonous materials to quantities that will minimize loss of life in case of disasters.

The equipment at the sampling stations should be augmented to provide for continuous radiological warfare monitoring. In addition, the stations should be made collection points for airborne biological-warfare agents. The nervous tensions of wartime periods definitely increase the apprehension of the population in respect to unusual area odors, smoke clouds, or atmospheric disturbances. Knowledge that a program of constant vigilance was in effect would be assuring to the citizens. The problem of area panic or hysteria that might lead to a frantic mass exodus or mass hysteria of the “man from Mars” type is very real.


In addition to reports of researches on coal (chemical examination, carbonization, and gasification) and on other fuel problems, the report deals with certain aspects of boilers and steam-raising gas turbines, domestic heating, and atmospheric pollution. (APB)


This is the first of a series of 12 pamphlets dealing with separate phases of air-pollution abatement as related to the chemical and allied products industries. Historical and recent developments and responsibility for abatement are discussed briefly. Air pollution as discussed in the manual is defined as “the presence in the air of substances put there by the acts of man, in concentrations sufficient to interfere with the comfort, safety, or health of man, or with the full use and enjoyment of his property.”

252. INDUSTRIAL HEALTH MONTHLY. Air-Pollution Studies by Steel Companies. Vol. 11, 1951, p. 58.

Steel companies have been helping to lessen air pollution in their communities in increasing instances during recent months. Now a new attack on the problem has been launched by the Industrial Hygiene Foundation at Mellon Institute in Pittsburgh, under the sponsorship of the American Iron and Steel Institute.

Steel companies will make their data and equipment available to scientists from the foundation. New methods and devices for collecting samples of air will also be put to work. The program calls for an expenditure of $20,000 within 6 months to study steel-mill processes and atmospheric conditions surrounding many plants. The results of this preliminary research will determine whether a concerted effort by the steel industry in
developing air-pollution control is needed, and if so, along what lines.

Among the first problems to be solved is development of standard, practical tests for measuring dust and gas from furnaces. Data are now being collected to describe the quantity and quality of these wastes from several metallurgical processes and their ultimate "natural" disposal.

A smog chamber will be used, into which controlled amounts of sulfur dioxide, water vapor, and various pollutants having a catalytic action can be injected. Parting knowledge already has been done on this project. Results will promote a better understanding of the effect, if any, of smog on various aspects of health. Immediate research is being done in appraising smog incidence by locality.

Electrostatic precipitators for dust particles are now used in a number of plants. This equipment polishes the dust in a stream of air and attracts the particles to metal plates with an opposite charge. Coke-oven doors have been altered to reduce smoke leakage. Much of the smoke discharged from coke ovens normally comes when the coal is put in. A "smoke sleeve" has been designed to funnel this waste to a nearby oven where carbon is dissipated and gases are carried off. Control of the cloud of dust, which occurs when materials in a blast furnace slip, has been studied for years.


Hydrogen sulfide-rich gases, plus temperature inversion and fog, caused 320 casualties, including 22 deaths, in Pozo Rica, Mexico, on November 25, 1950. Petroleum produced in the Pozo Rica field is sent to Mexico City by pipeline for refining, and over 100,000,000 cubic feet of gas per day is processed at the site to recover gasoline and light petroleum gases. Until recently, the stripped gas was sent to flame, but the demand for repressuring the field and for a natural-gas supply for a new ammonia plant at Mexico City has changed this. A shortage of sulfur for ammonium sulfate production and the demand for low-sulfur gas was responsible for construction of a 120-ton-per-day sulfur-recovery plant in the oil field. At the time of the accident, the hydrogen sulfide stripping columns were going into operation; half of the plant was processing 80,000,000 cu. ft. of gas per day. The sulfur-recovery units were not completed, however, and the hydrogen sulfide-rich gas was burned without further processing, and the rate of 10,000,000 to 11,000,000 cu. ft. per day. The composition of this gas was 81 percent carbon dioxide, 16 percent hydrogen sulfide, and 3 percent hydrocarbons and water. Auxiliary lines delivered 200 cu. ft. per minute additional natural gas to the flare to insure combustion. Inspection of the nozzles of the gaslin showed this to be partly filled with sooty material. It was concluded that failure of the burner for a short time allowed the hydrogen sulfide-rich gas to escape and flow into the village adjacent to the flare. The immediate closure of the hydrogen sulfide recovery plant probably prevented further fatalities and illness. Present plans are to move the flare to a distant point away from the city. When the sulfur-recovery units are in operation, there will be little or no toxic gas released to the atmosphere. (PHEA)


It is pointed out that standards for measurement of atmospheric pollution are necessary and that valuable data can be obtained with inexpensive equipment near Louis, Mo., is cited as an example of the importance of systematic sampling in initial evaluation of the air-pollution problem and in measuring the effectiveness of remedial measures, once they are in operation. The use of low-sulfur fuels has helped to reduce sulfur dioxide concentrations in downtown St. Louis as much as 83 percent in winter and 73 percent in summer. (PHEA)


Tests by the California Institute of Technology indicate that the Los Angeles smog results from oxidation of organic compounds in the air. This organic material, mostly hydrocarbons, is oxidized by ozone, by the action of oxygen and sunlight and by the catalytic action of the nitrogen dioxide and nitrogen oxide cycle releasing atomic oxygen under the influence of sunlight. Peroxides, aldehydes, and acids are produced, and aerosols are formed that decrease visibility, irritate the eyes, and cause crop damage and cracking of rubber. In addition, side reactions such as the adding of the nitrogen oxides to the double bonds may occur, producing aerosols that act as eye irritants. Similar reactions probably cause oxidation of sulfur dioxide, although this source of pollution and that of metallic dusts have been reduced greatly by the cooperation of industry and enforcement agencies. (IHOM)


The pollution of the air in urban localities by smoke, and indirectly by pollution by the effluents from industrial processes is reviewed. The three main sources of smoke are domestic heating, industry, and transport. The domestic source is always important, but its precise contribution to the total pollution depends on climate and on the extent to which coal is used in the home. The contribution from industry depends on the number and nature of the industrial plants in the locality.

An epidemic is an unusual episode in the course of a disease. Smoke fogs produce their epidemics, such as the Meuse Valley incident in 1930, and the more recent trouble at Donora, Pa., in 1948. Complete understanding of such outbreaks depends on a study of the chronic endemic problems. Largely as a result of the Donora incident there is in America widespread official and public interest in atmospheric pollution.

It has been said that smoke produces no diseases peculiar to itself—but disease is the resultant of many forces that arise variously from a host and from the environment in which the host lives. Multiple causation of origin and cause is a principle that applies to all mass disease and mass injury.

Atmospheric smoke is a mixture of many potential agents, and the concentration of each varies in time and place. Each requires definition and study, so that an accumulated dosage scale may be determined in terms of concentration and time of exposure. Weather and terrain greatly affect smoke concentration, as do also socioeconomic factors, such as degree and nature of industrialization, methods of heating, population density, and transport. Health may be affected indirectly through smoke. Interference with sunlight may conceivably have psychological and metabolic effects, and influence risks of airborne infection and lower resistance to disease. All these considerations are discussed in detail, and experimental studies are reviewed.

In future studies the best possible use must be made of available data. Care must be taken to avoid faulty use of vital statistics. Indices of health and of pollution must be carefully chosen. Laboratory studies on animals are needed to study synergism and antagonism among components of smoke, infective agents, temperature, and atmospheric humidity in their action on respiratory tissue. Field studies of specific population groups are also needed. (95 refs. cited) (BH)
257. Oil, Paint and Drug Reporter. Air-Pollution Society Elects R. Griebing Executive Secretary. Vol. 158, No. 7 (1952). The Air Pollution and Smoke Prevention Association is an international organization 44 years old, with activities in the United States and Canada. Mexican memberships are expected in the near future. The organization was formerly known as the Smoke Prevention Association of America, but changed its corporate name at its last annual meeting.

Plans are at present being made to adopt practical standards for drawing up necessary municipal legislation. The association also hopes to advise industry on the development of the proper apparatus for the economical limitation of air pollution, to undertake research covering specific abatement problems, and to give wide dissemination to the results obtained, thus rendering an important public service on an international scale.

Air-pollution problems in the Far West are discussed. Almost most fuel used is natural gas or oil; therefore fumes and gases are important, rather than soot, smoke, and fly ash. The annually burning of 50,000 tons of fuels and rubbish is the principal cause of Los Angeles smog. 2,000 tons of chemicals being emitted. Legislative control is outlined. Every person who discharges air contaminants must have a permit. Research on waste discharged to the air and their dissipation by meteorological conditions may save some of the cost of corrective equipment. Plans for industrial plant should consider the air-pollution potential and anticipate future regulations. (AIP) 44th Ann. Conv., 1951, pp. 107-110.

Projects completed were fly ash collection and elimination of hydrogen sulfide. The fly-ash problem was handled successfully with standard equipment, but disposal of hydrogen sulfide required special attention.

One of the most acute community problems arose in connection with municipal sewage system used extensively by industry. Gases and odors emanating from the sewers affected several districts, residential and business, presenting a rather unique abatement problem. Among the more difficult phases of the work were development of suitable sampling and analytical techniques necessary for definition of the problem. Dissolved organic materials in the industrial waste waters were found to be present in the gases.

Several possible solutions of the problem are presented.

In Burnley, the smoky atmosphere caused by industrial and domestic fuel consumption is the same serious problem as that experienced by most heavily industrialized towns.

In an endeavor to get the people of Burnley "smoke abatement minded," a series of six free lectures has been planned. The lectures will deal with the various aspects of the subject, such as the evil effects of smoke, cause of smoke, and prevention.

Nine national technical meetings held during 1949 and 1950 were devoted to air pollution. Over 220 technical papers were presented at these meetings.

This increase of attention to air pollution as a nationwide problem was initiated by the emergency in 1945 of Los Angeles smog as a local problem of the first magnitude. The Donora smog episode aroused the hitherto complacent East, just as the Los Angeles smog has stirred the West.

In reporting the present status of knowledge, only the high spots are covered. Some of the subjects at the various meetings are discussed briefly. The principal benefit realized from the many meetings and papers of the last 2 years has been the consolidation and organization of the much scattered existing knowledge into the papers and progress reports required to round out these several symposiums. As a result, when these contributions have been published the public health officer will for the first time have a comprehensive library on air pollution. (15 refs. cited) 1952

Discusses ways and means of getting newspaper publicity for the air-pollution-control department.

To do the job as well as possible, the air-pollution-control official must first of all know something about newspapermen and the manner in which they work, then he must learn to fit his own news into their method of operation.

Air pollution poses perplexing problems, both economical and technical, according to a statement released recently by the Citizens Committee of Cleveland for Air Purification. Yet, despite these difficulties, Cleveland has made substantial progress since 1946 and will continue to make it. This progress includes:

(1) Reduction in citywide air-pollution deposits (soot, dust, cinders, etc.) from 38.2 tons per square mile in 1949 to 35.6 tons in 1950.

(2) Since 1946, when the monthly deposit per square mile was 51.5 tons, air-pollution deposits have dropped 31 percent.

(3) A 50-percent drop in number of plants emitting nuisances from industrial processes in 1950.

(4) Seventy-four percent less industrial smoke than in previous years.

Case histories of the results of cooperation of various industries in air-pollution control are discussed briefly.

An apparent reversal of the usual application of the zoning principle is indicated by a recently amended zoning ordinance of the city of Raleigh, N. C., to exclude residences from industrial districts.

The change is in accord with present-day zoning theory, which is based on the facts that, when residences are permitted in industrial districts (1) tracts necessary for industrial purposes are subdivided and rendered difficult to assemble, (2) the city is forced to provide schools and similar facilities in a patently unsuitable district, (3) inhabitants are inclined to harass industries with complaints about the normal noise, odor, dust, etc., associated with industrial operations, and (4) the area is unsuitable for healthy and pleasant living facilities.

265. —. We Don't Have All the Answers. Vol. 2, November 1952, pp. 52-53.
In June a public hearing was conducted in the Baylor Medical School auditorium in Houston, Tex., to give citizens in Harris County concerned with air pollution an opportunity to express their views.

These views, quite naturally, pointed the finger at the polluters—industrial firms in the ship-channel area. Following the spirited hearing, the authorities felt it was only proper to allow industry to tell its story.
Accordingly, another hearing was called for August 20 to publicize the problems and progress made by industry to date, as well as the plans which are being formulated to minimize present evil conditions.

The testimony of officials and representatives of industry was so interesting that great parts of it are presented as documentary evidence of a history-making event in Texas. Statements by 12 officials and representatives of industry are quoted.


Because of the uncontrolled complexity of the contaminated atmosphere to be studied, the statistical approach appears to offer a means of finding solutions. Therefore, "The statistician should be a member of the research team in the planning stages." The role of the statistician is discussed under the following headings: Design of the experiment; operation of the study; analysis and presentation of findings. (FHEA)


Over a million dollars has been spent in recent years by several agencies in studying Los Angeles smog. For the most part, this money has been intelligently spent. Much is now known about smog. Perhaps even more important, what is still to be learned is at least partly dependent on that fact lies the hope for the future.

As long as smog brings tears to the eyes of citizens of Los Angeles and obscurity to their views, the pressure for a solution will remain. As long as the public pressure remains, money will be found to support research on smog. And, in the long run, it may confidently be stated that research will reveal what must be known about smog. Given that understanding, smog perhaps can be eliminated from the fascinating climate of the Los Angeles Basin.

The history of smog occurrence in Los Angeles, causes, and effects on health, visibility, structures, and materials are discussed.

At present, scientists are not in a position to scoff too openly at the multitude of "experts" who offer solutions to the smog problem. At least one generality may be put forth with confidence. The way—and probably the only way—to eliminate smog is to find out exactly what materials are in the air, and how these materials are the cause of their history after being airborne, the mechanics of their action, and the means by which they exert their effects.

These matters must be understood not only with respect to eye irritation, but to crop damage, effect on health, visibility, and many others. Some of the answers are now available. But more extensive knowledge, it now seems, is needed. This means that a great deal of fundamental and basic research is called for.

When the basic principles and their applications controlling the action of smog are understood, and only then, are we likely to understand enough to be really intelligent about decreasing the sources of smog and returning the famous climate of southern California to the Los Angeles Basin.


Reports the Second National Air-Pollution Symposium. A brief summary is presented of the various papers on atmospheric pollutants, fundamental chemistry and physics of the atmosphere, combustion as a contributor to air pollution, and biological aspects of air pollution.


Review of the disasters in Donora, the Meuse Valley, and Pozo Rica revealed that certain factors were common to all, in that there was a period of atmospheric stability in all three episodes. In Donora and the Meuse Valley, there was a similarity in both the heavy concentration of industry and the type of terrain. Investigators for Donora and the Meuse Valley, singled out sulfur compounds as the potential causative agent, while for the Pozo Rica disaster, for the first time in the history of air pollution, the causative agent, hydrogen sulfide, was defined. (Author's summary)


After many conferences between city officials and advisory boards of leaders in engineering and medical fields organized to assist in planning, guiding, and promoting the Detroit-Windsor Air-Pollution Study, five objectives have been established. They are: Determine sources, nature, and amounts of atmospheric contaminants resulting from combustion of fuels; determine sources, nature, and amounts of atmospheric contaminants resulting from industrial processes; determine effects of meteorological factors in the areas on dissemination and diffusion of atmospheric contaminants; determine the effect of atmospheric contaminants upon health, vegetation, safety, and economy; determine what controls are necessary, their cost, and by whom the cost should be borne. The principal factors involved in accomplishment of these objectives are discussed. (FHEA)


The effects of terrain and temperature inversion, the sources of pollution, that is, smoke, dusts from cement, lime, mineral, wood, iron and steel, and rock-crushing industries, gases from chemical, paint and smelting works, and odors from packing and food plants, are reviewed briefly, and their prevention is discussed. Smoke can be reduced by dust catchers, cyclone and electrostatic separators, and washing of flue gases. The latter process causes corrosion, costs 35s. a ton of coal burned, and cools the flue gases, so that they are apt to fall and cause trouble. Other methods are replacement of obsolete boiler plants, raising height of chimneys, and increasing gas-outlet velocity. The value of process dusts can sometimes be recovered if the temperature is not too high. The absence of good simple means of measurement for smoke, and of any means for gases and odors, is deplored. (APB)


This bibliography contains more than 1,500 references on air pollution, its causes, effects, its control and abatement, and many other miscellaneous related subjects.

Originally it was proposed to include in the bibliography only fundamental and significant contributions to the problem of air pollution and its control. However, it rapidly became apparent that, owing to its complexity and because of the still great lack of exact scientific knowledge, it was extremely difficult to choose between degrees of usefulness of the references available. As a consequence it became necessary to attempt to include reference to all that has been written on the subject, than to attempt to be selective in a problem which involves human opinion as well as factual science, to such a marked extent.
It is hoped that this compilation will be of real value in the continuing efforts being made by industry, Government agencies, and the public in the abatement of air pollution.  


First of a series to be issued to supplement the references compiled in the Bibliography, chapter 12; was published during the spring of 1952.  

The references in appendix I were compiled during the first half of 1952. These include not only new material published during that period, but also references of previous years which were overlooked and omitted from the original publication.  

It is hoped that the format and methods of classification employed in the bibliography have proved acceptable and useful to those who have consulted this reference source. As this first supplement to chapter 12 indicates, the same format and methods of classification will be employed in forthcoming editions, unless enough reason should be offered for revision.  

Supplements to the Bibliography will be issued every 6 months in an effort to keep the reference material as up to date as possible. These will be issued in a loose-leaf form enabling the user to keep the material together conveniently. A revised index will be included with each appendix.  


The area is to be sampled by continuous observation over a long enough period to evaluate the effects of pollution on health, economy, safety, and vegetation. Determining sulfur dioxide pollution (one of the major contaminants in quantity in the area), particulate matter, and deposited matter is discussed as well as the effects of air pollution on public health and welfare. (PHEA)  


The economic, agricultural, and health aspects of excessive air contamination have become more acute with continuing growth of industry and population in Canada. A review is given of the nature of this problem in some smelting districts and urban areas. The Trail Smelter case is an outstanding example of successful solution of an international air-pollution question with important scientific aspects which led to new developments in regard to effects of sulfur dioxide on vegetation and control measures, resulting in the creation of a huge byproduct fertilizer industry. The current Windsor-Detroit urban pollution problem illustrates the close cooperation in scientific effort which has been achieved in this field under the International Joint Commission.  

The effects on vegetation and health are discussed and various control methods and emission standards are also considered in the light of recent developments in Canada, the United States and Great Britain. (68 refs. cited) (Author's summary)  


Attention is called to the trend toward deleting the word "smoke" from organizational titles. This trend indicates official and public recognition that smoke is but one of a multitude of contributing causes of air pollution.  

The term "air pollution" signifies the inclusion of all airborne contamination, and the word "control" denotes power of authority to regulate, check, or keep within limits the effluence of all pollutants.  

There is relatively recent public realization of widespread emanation of invisible toxic or noxious gases that are far more harmful to human life, plant life, and tangible properties than is smoke from burning of fuels.  

The success of the cooperation between the members of the National Association of Power Engineers and the Louisville control officials in control of air pollution is emphasized.  

Some of the measures applied to the problem of control of offenders of the air-pollution regulations are outlined. The conclusion is that the city of Louisville has a good, comprehensive, air-pollution-control program.  


Describes causes and effects of smog. Emissions to the atmosphere are analyzed and pollution levels from 1948 to 1951 are recorded. There was a 31-percent decrease in smoke, 40-percent in dust and fumes, and 50-percent in sulfur dioxide and a slight increase in unsaturated hydrocarbons. The theory is argued that the oxygenated and peroxydized hydrocarbons present in smog as aerosols, gases, or vapors arise from the catalytic (cold) oxidation of hydrocarbons by the oxides of nitrogen and from reactions with atomic oxygen or ozone. Details are given of the effects of smog on vegetation. Technical and administrative methods are described. (APB)  


Methods of analysis of pollutants, chemical and physical properties of Los Angeles smog, total daily emissions of contaminants, reduction in pollution levels, and effects of smog on vegetation comprise the body of a recent publication by the Los Angeles County Air Pollution Control District entitled, "Second Technical and Administrative Report on Air Pollution Control in Los Angeles County." This is the fourth annual report of this agency and the second to treat technical phases of the Los Angeles problem in detail; it is the most significant and complete thus far.  

The 52-page report is illustrated with 35 figures and 28 tables. The first five sections are directed toward the layman and explain why smog occurs, what effects it has, what controls it, how it is controlled, and how the Air Pollution Control District functions.  

Methods for the collection and analysis of more than ten classes of pollutants are disclosed in detail and include: (1) Lower aldehydes, (2) hydrocarbons, (3) organic acids, (4) ozone, (5) total oxidants, (6) oxides of nitrogen, (7) hydroperoxides, (8) sulfur dioxide, (9) carbon monoxide, and (10) aerosols.  

Concentrations of over 15 contaminants in downtown Los Angeles during smog periods are compared to concentrations during clear periods. Ozone concentrations doubled during smog periods and hydrocarbons increased five times over the concentrations determined during clear periods. (5 refs. cited)  


Reference is made to various phases of the air-pollution problem. A research program with an initial appropriation of $25,000 has been approved for studying air pollution in the Chicago area. Recommendations for preventive measures are included. The fight against smoke and smell in the air breathed deserves the support of all public-spirited citizens and industry.
Air pollution may be approached from two points of view—public health and engineering. The maximum permissible concentration of many contaminants which will be harmful in the community is not clearly established. Technology is available to practically eliminate smoke and handle most of the fly-ash problems. Each plant industrial problem must be analyzed individually to secure the most economical solution of the problem. A great deal of information is available as a guide in sampling and analyzing air contaminants. The newer techniques make possible the determination of the concentration of air contaminants at various altitudes as well as at ground level. Meteorological observations at chimney-top level and higher are important. A new continuous aerosol analyzer and dustfall collector indicates the wind direction from which the largest amount of air contaminants are coming. A low-velocity wind tunnel, condensation-nuclei recorder, miniature Venturi scrubber, and other equipment are being perfected to furnish specific information.

Close coordination among the public health and air-pollution officers, industry, and research organizations is required for the most rapid progress. Education of all parties concerned will be necessary. With a cooperative effort, progress will be made and the air will gradually improve as additional equipment is perfected and used. (AIIHOM)


Four papers were presented which discussed the problems from the points of view of the industrial engineer, the industrial architect, the supplier of equipment, and the workers in and residents near industrial operations respectively. (APB)


Brief summary of the findings and recommendations made in a report on the air pollution problem at Seattle. (APB)


A case study of the air-pollution problem and its solution from the standpoint of legislation, meteorology, and engineering in various industries is given. (APB)


The attitudes adopted by authorities in various cities toward air pollution by oil refineries and other industrial offenders are summarized briefly. Some are adopting a reasonable attitude toward industry and are trying by education and assistance to improve the situation. Others are wielding a big stick.

What some of the oil companies and other industries are doing to solve the problem of air pollution is presented.

In general, to conduct a study of air pollution, it is necessary first to perfect methods of accurate measurement of pollutants and determine sources. Source studies must include minor human activities, such as trash burning, as well as large industrial enterprises. Interpretation of analytical results is of major importance after sources have been discovered, samples taken, and analyses conducted.

Generally recognized effects of air pollution are of three basic types: Nuisance, economic, and health. Dirt, offensive odors, loss of visibility, and eye irritation are of the nuisance type which may create much of the public outcry against industry. More important economic effects include discoloration of paint, corrosion, soiling of clothing, household furnishings, and store merchandise, and injury to vegetation and livestock. Health effects have been highlighted in recent years by the Donora tragedy and more recently by the loss of life in Mexico due to hydrogen sulfide.


The origin of the Los Angeles smog and the difficult problems to be solved in its control are presented.

The true complexity of the Los Angeles smog problem as revealed by research has clearly and dramatically shown the way for any community to intelligently approach its air pollution problems. While specific pollutants, including smoke and noxious chemicals, should be regulated by law, intensive research must be sponsored in order to determine what contaminants are present, to assess their importance, to determine their sources, and to encourage the development of sound technical and economic means for reducing such effluents.
NATURE AND ORIGIN OF POLLUTION

1819


1854


1861

Brief history of apparatus, and discussion of causes of smoke. (MIR—Bib.)

1880

An informative discussion is presented on smog in London and other industrial areas. The absence of relationship between the usual radiation fog or mist and the dark, dirty, smoky fog (smog) occurring at times over industrial cities is pointed out clearly. The burning of soft coal in the homes, rather than emanations from industry, is blamed as the chief contributor to the smog. The smog is described as lying close to the ground, very dark, and requiring artificial light on a cloudless day. This is contrasted to mist or fog which does not absorb the light. The loss of sunshine, the corrosion of buildings, and the possible effects on health and life expectancy are mentioned in detail. (USPIS)

1883

Reviews history of smoke nuisance and efforts to prevent it. Experiments seem to show that smoke, when once produced, cannot be made unobjectionable. (MIR—Bib.)

1890

Sources of coal smoke, advantages of prevention, and description of preventive apparatus are discussed. (MIR—Bib.)

1891

Before the Alkali Act of 1881, the conditions connected with the manufacture of superphosphates from manure were frightful. Now it is much better. The noxious vapors must be distinguished from the powerfully offensive and searching stinks from bone-boiling and blood, fish, and flesh-offal treatment. Stifling fumes of mineral phosphates treated with H2SO4 consist of fluoric, carbonic, and sulfuric acids, and steam, and unpleasant oily vapors. On the Tyne 4 or 5 tons of HCl would be discharged from South Carolina River phosphate in a week. Apparatus has been devised for arresting manure-works vapors. These vapors contain all the ingredients necessary to deposit themselves, and but one condition—heat—to retard this. For this reason, instead of the use of steam, cooling is done by flues with baffling diaphragms. This takes out the solids. The gases traverse one or more water towers, wet scrubbers packed with wedge-shaped wood spars, before emerging at the chimney. The draft is a forced draft by exhaust fan.
In the discussion preference was expressed for a flue of about 200 ft. between the mixers and scrubbers.

1899

Evils of smoke in England and a plea for abatement are considered. Does not consider methods. (MIR—Bib.)

1902

Editorial discussion of effects of imperfect combustion of soft coal and of means for prevention. (MIR—Bib.)

1904

Deals with extent of the smoke nuisance in England, with considerable attention to physiological and psychological effects. (MIR—Bib.)

1909

Production, estimation, and prevention of smoke, and the problem of municipal control. (MIR—Bib.)

1908

Note on opinion at Manchester and summary of conclusions in report of Syracuse (N. Y.) Chamber of Commerce. (MIR—Bib.)

1909

Brief summing up of causes and prevention of smoke. (MIR—Bib.)

1911

299. Lodge, Oliver. Science and Smoke. Smoke Abatement Conf. at Sheffield, 1909, pp. 5-11.
Discusses generally the harmful effects of smoke, and its wastefulness. (MIR—Bib.)

1912

General discussion of the smoke nuisance. (MIR—Bib.)

1912

Conditions for formation and abatement of smoke. (MIR—Bib.)

Briefly discusses cause and remedies. Pittsburgh is the only place definitely mentioned. “So great is the nuisance that white articles of external dress are almost discarded in consequence of their becoming immediately soiled.” (MIR—Bib.)
NATURE AND ORIGIN OF POLLUTION


Estimates and comments are made on loss in fuel value, loss from damage of smoke to property and health, and effect of smoke on vegetation and the atmosphere. (MIR—Bib.)


The henceforth historic “haze of 1912” appears to have registered itself unmistakably in the evaporation records of the Great Plains and the intermountain districts of our Western States. This subject is discussed on the basis of measurements made at a number of evaporating tanks during the past 5 years. As compared with the “normal” for the whole period of observation, the average evaporation measured at 15 stations during the 4 months after the Katmai eruption was generally about 40 percent, or an average reduction amounting to about 10 percent. This corresponds fairly well with the reduction in solar radiation observed by others during the same months.

305. —. Vol. 108, 1913, p. 171.

The remarkable haziness of the atmosphere that began in June 1912 and persisted at least well into the autumn continues to be the subject of numerous reports from widely scattered points in the Northern Hemisphere. Dr. A. de Quevain, the leader of the Swiss expedition that crossed Greenland last summer, states that blue skies prevailed on the west coast early in June, before the party started. During the crossing, however, June 10 to August 1, the members of the expedition were struck by the gray, leaden appearance of the sky, in the absence of clouds, and even when the explorers were traveling at altitudes above 8,000 feet. The Eskimos of the east coast were terrified at this uneventful phenomenon, which they believed to be an omen that the following year would have no summer. A report from Zurich states that the haze ceased to be noticeable at the Swiss observatories about October 11.


Smoke observations were made on the stacks of 152 stationary plants, about 40 percent of which were violating one of the most lenient smoke ordinances of any large city of the United States. Fifty percent of the stacks of the front-feed stoker plants were violating the ordinance.

The two main sources of smoke in the city and district are the manufacturing plants and the railroads. The report concludes that the solution of Pittsburgh’s smoke problem lies in inducing the small group of men in control of the plants that produce at least 80 percent of the smoke to apply the best modern engineering practice to the combustion of fuel in their plants. It is emphasized that there is nothing impossible or wonderful about the smokeless combustion of even Pittsburgh coal, provided proper methods are applied and ordinary precautions taken.


The Katmai dust cloud, which caused a general haziness of the atmosphere over much of the Northern Hemisphere, reaching a marked maximum in August 1912, appears to have now practically disappeared. The duration of this cloud was somewhat less than that due to the eruptions of 1902-3, which lasted 2 years, and marked lessly by the dust ejected by the great Krakatoa eruption of 1883.

1915


The effects of volcanic dust upon climate have formed the subject of numerous publications during the last few years, the more noteworthy being those of Abbot and Fowle, and Humphreys. The subject has now been taken up anew by Dr. H. Arctowski, well known for his researches on so-called “pleionian” variations of temperature and other atmospheric conditions. He finds that the dust cloud produced by the Krakatoa eruption affected atmospheric temperatures very greatly, while the violent eruptions of 1902, as well as Katmai eruption of 1912, influenced the yearly mean temperatures but very slightly, or not at all. The pleionian variations of temperature have nothing in common with the presence or absence of volcanic dust, but an influence of the sunspot variation upon the changes of atmospheric temperature is undeniable.

1927


The question of fumes in the large cities has become of capital importance for the public health. It has been exposed in the first number, 1927, of the Annales d’Hygiène Publique, Industrielle et Sociale by de Bissoux and by P. Bordas in No. 12 of 1926. These two authors have shown how the products of combustion succeed in polluting the atmosphere in the form of fumes, dusts, hydrocarbons, or sulfuric and nitrous gases.

According to Bordas, who has made researches for many years in England, in the United States, in Germany, in Belgium, in France, there is known, usually in Paris in the atmosphere 13,000 tons of benzol, 27 tons of heavy oil, and 44,000 tons of ash. Byproducts are also lost, a part of which we absorb at each respiration.

It is remarkable that in Paris, where the thickness of the fogs seems to increase each year, the public authorities are not much occupied by this condition and have not exerted as great efforts as in England. What they have done up to the present is insufficient; it is easy to determine each time that it is good weather in the country and that one encounters in Paris the dark color of the air that covers the city and diminishes the luminosity. It is not alone the fumes and the dust that are in play; but also the byproduct of the combustion of the fireplaces and the motors of automobiles and the heavy and malodorous hydrocarbon.

A report to the Municipal Council reference was made to an edict of 1832 for the suppression of fumes in Paris. The edict, however, remained a dead letter.

1950


In modern industry gases and fumes may be liberated in considerable quantity, either from raw materials or
as by-products in the course of different processes or at times by the finished products. It is for this reason that the risk of inhaling gases and fumes foreign to the nature of pure air has become increasingly extensive.


The California Department of Agriculture and Public Health in that state has actuated as a public nuisance the smudging operations intended to prevent frost damage in orange and lemon groves near Pomona and Chino, Calif. A survey revealed that 75 percent of the smudge pots used in the citrus fruit groves of southern California were inefficient homemade contraptions that emit dense smoke and soot which jeopardizes and endangers public health, and causes much damage to house furnishings. On mornings when such operations were in full blast the lower atmosphere was filled with sooty fog that injured everything with which it came in contact and made life almost unbearable.

1936


The people of the United States have become "dust conscious" in the past few years because of the "black storms" that have occurred from time to time. Great clouds of dust have been blown from the so-called "dustbowl" of eastern Colorado, western Kansas, the Indian reservation of Texas, and wide areas of Oklahoma across the Mississippi Valley and Eastern States. In their wake large quantities of fine silt and sand. During such storms the air has been so filled with dust that the sun has been hidden from view and living conditions generally have been very unpleasant.

To give some idea of the volume of dust in the air during one of these storms the following data have been obtained from the University of Wichita (Kans.), one of the cities in the path of the storm of March 20, 1935. At 11 o'clock the sky was completely filled with dust particles, and the visibility was not over 300 feet. The wind velocity was low, but an unmistakable drift from the west was evident. Motorists from Colorado reported the storm as far west as the Kansas State border.

At this time two students of the University of Wichita decided to measure the amount of dust in the air. Each took a beaker, such as is commonly used in chemistry laboratories, and placed it on a balcony of the second floor of the Science Building. After 2 hours the beakers were removed and the amount of dust in each weighed. The first beaker contained 0.06 gram of material. The second beaker contained 0.0002 gram. It was calculated that this amount would equal 0.6 of a pound or 9.6 ounces in a cubic yard and 1 cubic mile would contain 327,000,000 pounds. Wichita covers approximately 30 square miles, and it was estimated about 5,000,000 tons of dust was in the air above the city when this test was made.

Samples of the dust were sent to mineralogists for examination to determine its composition. It was reported that it was composed essentially of two minerals, orthoclase, feldspar and quartz. The feldspar made up about 75 percent of the sample, and less than 20 percent consisted of other minerals than the two mentioned. Among those were biotite, a species of mica, volcanic ash, and pyroxene, a metamictite.

While these severe dust storms cause shutdowns of machinery in the oil fields and necessitate cleanups after they have passed to remove the accumulated dust, they are not of great importance. But it is known that there are dust particles in the air at all times that will enter the cylinders of engines and get into bearings of machinery and cause unnecessary wear. This dust is of much the same composition as the material caught during the heavy dust storms; this is all hard rock and does considerable damage to machinery.


An English authority on dust states that it is rare to find any location on this earth where the dust particles in the air are less than 600 to the cubic inch. On the Atlantic Ocean there were found 12,000 and in London 60,000 to 200,000 particles to the cubic inch. Mine atmospheres are considerably worse. The silica particles under 12 microns (a micron is one twenty-five-thousandth of an inch) in diameter do not exceed 2,000 to the cubic inch, or approximately 4,000,000 to the cubic foot. In a cubic foot of air in the outskirts of Paris dust particles carried 50 mold spores and 80 bacteria, while in the city these figures were multiplied by about ten. In a dwelling the micro-organisms in the air were found to range from 250 to 1,800 per cubic foot of air. Even with 2,000,000 particles of dust in a cubic inch of average radius of 1 micron, but one millionth of the space would be occupied by solid particles.

1937


The thesis of this paper is the cause of the Meuse Valley incident with an attempt to place the blame on fluorine and its compounds. This report, written long after the disaster, suggested that the subject of fluorine, its compounds, and their toxicity were not understood at the time of the disaster. It is claimed that the data, together with a better understanding of fluorine toxicity, places responsibility on such compounds as the cause of the incident. (USPHS)

1938


For domestic use, firewood is the most desirable fuel; it gives a cheerful flame and induces active ventilation. Bituminous coal is the least desirable, on account of its high content of volatile matter. Anthracite and steam coal represent only a small proportion of the coal consumption. Theoretically a well-tended industrial furnace should be smokeless, and a domestic grate should smoke but little, but practice is far from theory; all chimneys smoke and smoke and some to excess. Legislation controls only industrial smoke; but in the Seine Department 50 percent of the coal consumed is burned in domestic grates, and it can therefore be said that nearly all the coal burned in the Department produces abundant smoke.

The burning of crude bituminous coal in domestic or industrial fires should be forbidden. Fuels rich in volatile matter should be burnt only in fires after distillation treatment—this is desirable on grounds of economy as well as of health.

1939


There is still very little reduction of atmospheric pollution, in spite of the publicity given to the subject of smoke abatement. There is one cause of concern. In industrial areas where coal, coke, and steel are produced are discussed. It is pointed out that it is very difficult to keep down the smoke from colliery boilers, for they use unmarketable fuels of high ash and moisture content, and as steam demand fluctuates heavily the fires often have to be "forced." A greater cause of air pollution is found in the huge tips and spoil heaps, where waste from the pits is deposited. The majority of these tips undergo spontaneous combustion, which is very difficult to check, once established. The best preventive method is to place some inert material be-
between specified thicknesses of colliery waste, but it is expensive. Coke-oven plants often cause a great deal of heavy smogs are appearing which increase the incidence of respiratory disease. Leeds experienced one of the blackest smogs in its history during January 1940, at which time a death rate from respiratory diseases soared to a high level.

It is argued that to allow deterioration in smoke abatement enforcement damages the health as well as wastes fuel. (USPHS)


In uncontaminated country air, bell values of 8 = 1.1 - 1.4 can be expected, that is, a bell glass exposed for 100 hours ordinarily would contain 1.1 - 1.4 mg. S. In the vicinity of settled areas values of 8 = 5 are obtained, although the air contamination cannot be roughly detected. Values of 11 - 14 are found in the center of the city, at least in winter. The contaminating effect of S-containing waste gases from the heating of buildings is evident here. Repeated determinations showed good agreement (only about 5 percent deviation for the mean). The procedure is most useful in the study of industries as sources of air contamination from waste gases containing H$_2$SO$_3$. The degree of air contamination decreases rapidly with increase in distance from the source of the waste gases (from more than 300 at a distance of 270 meters to 3.3 at a distance of 5,000 meters). Care should be taken in selecting the place for setting up the bell; during heating periods it should not be placed on roofs but in locations where the wind has free access. The bell values are closely connected with the configuration of the country and the atmospheric conditions. Only in completely level country do wind and weather alone determine the distribution of the waste gases; valleys and ridges of hills exert essential influences. Extraordinarily high S values are found during prolonged fogs. The bell value expresses air contamination as SO$_2$ if no source of waste gas is active which sends SO$_2$, H$_2$SO$_3$, or S-containing salts into the air. Other procedures, as the Zepf and Vetter method, must be used if peak values are desired. When the bell values are 30 - 35 in dry weather, the air has an acid taste and the sharp odor of H$_2$SO$_3$, but it is notintolerable to man. Damage to vegetation can be expected when the value exceeds 50; it is certain at 70. If an S value of 25 - 30 is found in the vicinity of an industry, an increased output of H$_2$SO$_3$ should be prevented to avoid damage to vegetation. The S value alone cannot be taken as an indicator of the purity of the atmosphere, since it does not include other possible contaminations (through flying dust, HCl, Cl, phenol, etc.). (JIIHT)

1944


The nature of harmful and otherwise objectionable atmospheric contaminants is discussed. The principles upon which the methods for determining the concentration of gaseous contaminants are based and the concentration, composition, and size properties are considered. Suggestions are made for the collection of comparable data. Additional information on the concentration of atmospheric contaminants, especially the particulate ones. An excellent bibliography (120 refs.) is included. (JIIHT)

1945


With special reference to teaching, the formation and nature of fog are discussed, and the part played by air pollution is stressed. It is pointed out that, during a smoke fog, the smoke particles near the top of the fog absorb a large proportion of the sun's rays and thus increase the air temperature at the top of the fog layer. The result is to strengthen the inversion, and in this way fog may persist all day over large towns while in the country it yields to the influence of sunshine. Methods for teaching this aspect of weather study are suggested, as are the taking of observations by school children. Reports coming in from the different parts of a city or other large areas can be valuable in building up a picture of the growth and the distribution of fog. (FA)

1945


Observations were made at Parks airfield 1936-38. The industrial areas of St. Louis lie in the quadrant NW to NE. The fog maximum in January and a lesser maximum in June, the latter being due to cold fronts. Air mass analysis of the fog situations is sketched.


Data were obtained on the quantity of each fuel type burned in New York City in 1935, its geographic dis-
tribution, and the number and size of each unit of fuel-burning equipment. Air pollutants consisting essentially of smoke, cinders, fly ash, and fine gases from the combustion of fuels are discussed. The study was directed toward providing data on the type, location, and intensity of air-pollution sources so that their abatement might be intelligently planned.

The study included and discussed an extensive fuel survey, which comprised a marine survey, an automobile survey, a railroad survey, and a survey of industrial, commercial, and residential usage. Also included is a survey of fuel-burning equipment, an estimation of area consumption, studies of grate areas used, and indices of air pollution. The paper includes charts and tables, statistical in nature, showing the findings of the investigators. (CLAC/UCLA)

325. Swartout, H. O., and Deutch, I. A. The "Smog" Problem. Los Angeles County Office of Air Pollution Control, 1945, 14 pp.

A nontechnical discussion of the sources of "smog" (smoke and fog) in Los Angeles and of the preventive measures used and desirable. The sources are discussed individually under the classification: Industrial plants; locomotives; diesel truck and automobile and bus exhausts; and combustible rubbish. The liability of Los Angeles to experience periods of temperature inversion and the range of mountains to the north are also contributory agents to the problem. Legal aspects of pollution control are discussed and future plans outlined. (FA)

1946


Smoke production during the burning of hydrocarbon gels has been investigated. The weight of smoke formed has been determined and the obscuring power of the smoke cloud measured by an optical-density method. The burning characteristics of the gels were also examined. These burning characteristics have been assessed by determining the unburned residue resulting from the combustion of a constant weight of gel with a constant burning area exposed, together with the time of burning and maximum and mean flame heights. The effect of the following variables on the above measurements has been investigated and discussed in detail: (1) Chemical composition of the hydrocarbon base. (2) Volatility of the hydrocarbon base. (3) Viscosity of the gel. For reduction of smoke formation, the composition of the hydrocarbon base was found to be most important, while the volatility was equally important in controlling the burning characteristics. The viscosity of the gel had no apparent effect on the smoke production. (APB)

1947


Where smoke comes from and where it goes; its causes and consequences; its measurement, available remedies, and the organization required to enforce such remedies, are discussed. (APB)


To check the air-pollution situation a representative group of inspectors was asked: (1) About what percentage of air pollution in your area can be charged to the use of coal in residential heating systems; (2) about what percentage of heating facilities are of modern design; (3) about what percentage of heating equipment is properly operated; typical replies are given relating to various States of the United States. (APB)


A survey of Toronto's atmospheric pollution problem is reported in which it was found that heavy industry, manufacturing, and commerce contribute to the problem in the order named, and that much of the smoke comes from the burning of wood waste, sawdust and shavings, and refuse. A total of 145 plants was surveyed, including 250 boilers and 392 individual pieces of heating equipment, and analysis was made of other factors which contribute to atmospheric pollution, such as topography, wind velocity and direction, industrial diversification, etc. Fourteen recommendations are offered. It is suggested that the quantity of smoke from domestic causes is usually overestimated. (APB)


According to a report to Newcastle Health Committee, inferior coal is thought to be the chief cause of a 30-percent increase in atmospheric pollution in the city during April, compared with the corresponding period last year. The subject is being discussed with the National Coal Board. In the industrial area of the city the recording instruments showed a deposit equal to 585 tons per sq. mi. a year, compared with 303 tons in April of last year. (APB)


Comment is made on the nature and extent of sulfur emission from collieries, coke ovens, gas works, boiler houses, iron and steel works, railways and locomotives, and electricity stations. Fuel supplies should be more uniform in their grading, and iron and steel works should have efficient dust-arresting devices fitted to processes where it is known that excessive dust is produced; this applies particularly to Bessemer process effluents and foundry cupolas. Nuisance from coke ovens and gas works requires further legislation, but colliery boilers and spoilbanks can be dealt with by existing legislation and immediate action should be taken with the National Coal Board. With regard to the nuisance from electricity power stations, a resolution suitable for presentation to the Central Electricity Board is given in draft form. (FA)


An attempt is made to give a general account of the causes and consequences of atmospheric pollution including statement of a policy for ending it. It aims to combine interest to the nontechnical reader, who approaches the subject for the first time, with assistance to those who are more closely concerned with the problem. The numerous quotes and references make it possible to consult in more detail works discussed only in simplified outline.

Under the heading, The First Coal Age, the author discusses the problem of the smoke nuisance, complaints of which began with the first use of coal for fuel. The nature of smoke, the reasons for its formation and the extent to which it pollutes the atmosphere are considered, followed by a description of the consequences of air pollution as they affect the individual and the community.

The first and most serious indictment is that polluted air is a direct menace to the health of the people who live in and breathe it; the respiration of polluted air under certain circumstances is even being reflected
in mortality rates. The loss of solar radiation is considered a more important factor although its effects may be less obvious.

Chapters are devoted to the effect of air pollution on plant life, the destruction of property, the squall of smoke, its cost, the problem of domestic and industrial smoke and measures for its abatement. Reference is made to what has been and is being done in various countries to solve the problem.

In regard to the prevention of smoke from the health standpoint, the statement is made that the general effects of the continued respiration of "normally" polluted air are likely to be insidious rather than flagrant, gradual and subtle rather than acute. For this reason the situation is more serious than it would be if there were distinctive symptoms and diseases recognizable as being solely due to air pollution.

The prevention of smoke is said to depend on the nature of the fuel, the appliance in which the fuel is burned, and the way in which it is burned.


The main source of air pollution is the burning of carbonaceous fuels in chemical and metallurgical industries. Results of an investigation of the distribution of pollution in a city and its environment at Leicester are discussed. The part played by the chemist in the study of pollution has been to devise methods of measurement for investigating the problems of the absorption of gases by physical and chemical methods and to endeavor to reduce pollution and to provide a valuable byproduct and eliminate waste. (APB)


The total smoke produced a year in Great Britain is estimated at 2.3 million tons, of which approximately half is from domestic grates. The total pollution by oxides of sulfur is about 5 million tons a year, of which one-fifth is from domestic appliances burning raw coal. The smokiest district in Leicester was found to be the center, and the maximum effect of wind was to move the point of maximum smoke concentration ½ mile downwind. It was found that 50 percent of the pollution in central Leicester was derived from outside areas. The mean smoke concentration at the center of Leicester was 0.17 milligram per cubic meter in summer and 0.41 in winter. Sulfur dioxide is removed from the air by natural causes more rapidly than smoke. The smoke-sulfur ratio is a useful aid for observing variations in pollution. The least smoke per ton of coal burned in Leicester was produced at the center and the highest in the inner suburbs. Smoke is due to imperfect combustion, particularly to tarry vapors. In a land-fired boiler the evolution of combustible matter is not constant; a maximum is reached soon after firing. Smoke eliminators have been described at the Fuel Research Station for forced and natural-draft marine boilers and for Lancashire boilers, which introduce, by simple means, enough secondary air at these periods of increased evolution of combustible matter. Tests made show that, when heavy smoke is made, about 2 percent of the heat may be wasted as visible smoke and an additional 6 percent wasted as combustible gases, such as carbon monoxide, hydrogen, and methane. The most efficient operation is obtained when only light smoke is made; the heat loss due to incomplete combustion increases at a rapidly accelerating rate as the smoke density increases. Reduction in domestic smoke can be achieved by designing more efficient appliances and using smokeless fuel.

Grit or fly ash from boilers can be removed by standard apparatus, such as cyclones, electrical precipitators, and water washers. The type of fly ash is influenced by the size of the combustible particles; the ash spheres are formed from ash particles lifted from the fuel bed or from the combustion of fine coal suspended in the air of flue gas. No satisfactory method of universal application has been found to reduce pollution by sulfur dioxide. Certain power stations have been equipped with systems for the removal of sulfur dioxide, but the processes are difficult to operate, and on a pay-as-you-go basis, cost 2-3 shillings per ton of coal burned. (FA)


After a 4-year campaign against the growing nuisance of "smog" over Los Angeles County, a newly empowered authority to combat the evil will avoid ordinary prosecution of establishments that pollute the atmosphere and will employ as its chief weapon injunctive proceedings designed to put such offenders quickly out of business. Unlike several other cities, the atmospheric problem of Los Angeles is not mainly one of coal dust and smoke but of industrial fumes. The accumulation reduces visibility to less than 1 mile and is extremely irritating to the eyes and nasal passages. Corrective measures have been blocked up to now by the multiplicity of jurisdictions in the county, which contains 46 incorporated communities, and by opposition from industrial concerns faced with big expenditures to suppress their fumes. Action by the last State legislature, however, authorized creation of a smog-control district embracing the whole county. (APB)


At the beginning of 1944, pollution figures in this industrial area had increased by more than 50 percent over those of 1939, while average smoke emissions per observation had increased sixfold. Many of the works find that the fumes supplied vary to such an extent that continuous adjustments of working conditions are necessary. Of 550 boilerhouses, about 500 are mechanically stoked, and many of the others would convert if they could obtain early delivery of the materials required. Perhaps the worst feature to record is that of taking mechanical stokers off boilers and fitting them with forced-draft hand-fired furnaces, thus creating a bad smoke nuisance and reducing the boiler efficiency in order that a poor grade of fuel can be used. Complaints have been made of nuisance from four large electricity power stations in the Don Valley, and from the fume supplies it is estimated that 1,175,000 tons of fuel per annum are burned, emitting about 107 tons of sulfur to the atmosphere each day. Since June last a leasing clause has been in operation in Sheffield, making it an obligation for all lessees to submit plans of heating apparatus. (FA)


Reference is made to the Donora, Pa., disaster in which 18 persons lost their lives and over 200 persons were incapacitated, of the effects of "smog." The conditions leading to these accumulations are well known to meteorologists. Frequently an inversion of temperature exists in which the air becomes warmer with increasing height before it becomes colder. With temperature inversion, whether or not associated with fog, upward diffusion of smoke is prevented, and it accumulates with the lid or ceiling of the inversion. With high-level inversion we have "high fog," in which
the air near the ground may be comparatively clear, but with low-level inversion the smoke accumulates near the ground, with disastrous results, if poisonous impurities are present. As so many of our industrial plants, iron and steel and chemical industries are situated in valley locations liable to low-level inversions of temperature, the Donora disaster is a timely warning that every effort should be made to avoid the emission of poisonous fumes and smoke from such establishments. If extraction of the objectionable ingredients is impossible or difficult, emission should only take place under noninversionary temperature conditions, in which case we have need for the improved local meteorological forecasting service proposed by Prof. D. L. Linton in the issue of The Times dated December 7, 1947. (APB)


In this staff report on the 13th annual meeting of the Industrial Hygiene Foundation, general remarks on health hazards of industrial gases were made. It was announced that the U.S. Public Health Service will undertake a comprehensive study of the nature and effects of contamination of the atmosphere by industrial wastes. (USPHS)


The report shows, for the year ended June 30, 1947, a total streetfall of 419.8 tons per sq. mi. in Cincinnati, against 453.4 tons for the year ended June 30, 1946. This is a reduction of 7.4 percent. Detailed studies are derived from monthly samples taken from 20 collecting stations by the City Bureau of Smoke Inspection. The deposits are established on the basis of 1 sq. mi. for each station and an average weight established for the entire city. (APB)


The principal sources of pollution fall into two categories: (1) those associated with certain industries, where much research and experiment is needed; (2) those capable of being remedied by means already to hand. (FA)


The southwest and west winds carry the dust and fumes of the industrial district over the city. At times the air becomes stagnant, and low visibility, high temperature, and humidity increase irritation of the eyes, nose, and throat. The sulfur dioxide concentration is usually considered a good index of the degree of industrial contamination of the air. There are some indications that sulfur dioxide may contribute directly to smog formation. Sulfur trioxide and sulfurous acid contribute to mist formation. Removal of sulfur compounds from waste products is difficult. About the only forths in which sulfur can be used as a raw material or chemical agent in any quantity are elemental sulfur, hydrogen sulfide, sulfur dioxide, and sulfurous acid. Many of the smog-contributing industries were started during the war, when smoke-eliminating equipment could not be made and air pollution control was lax. This must be remedied and new methods employed to alleviate the smog situation. (USPHS)


Results of a survey by the Coal Producers Committee for Smoke Abatement are presented. It was found that only 13 percent of the plant equipment in Detroit was hand-fired, yet 65 percent was found smoking. The reason is said to be mainly improper installation or operation. (APB)


The smoke problem in England is discussed. The British industrial smoke problem is similar to that in the United States of America. However, at least half of the smoke pall in England is due to open coal fires, which produce particularly harmful, tarry smoke. The object is to abolish completely this psychologically pleasant but wasteful and inefficient historical relic and replace it with gas heating, electricity, central and district heating, and solid, smokeless fuels. A complete ban on the continued manufacture of the old-style smoke-producing open grates and cooking ranges is expected soon.

The organization of smoke prevention in England is discussed. Some of the accomplishments that have been attained and prospects for the future are mentioned.


Atmospheric pollution from pulverized coal comes mostly from fly ash. A 200,000-kw. plant burning coal of 15 percent ash can emit up to 10 tons of ash per hour. Basic factors affecting the problem from coal preparation to final furnace design are discussed. (FA)


The National Survey of the Sources and Incidence of Atmospheric Pollution, discussed and approved at the recent Edinburgh conference, is now being carried out by the society. It is an attempt to discover, as comprehensively and accurately as may be possible, the specific sources of pollution, its incidence and its actual nature. Request for information, to be given by answers to questionnaires, has been sent to every local authority in England, Scotland, and Wales. The inquiry has been divided into self-contained parts. Part I asks for a short list of the most serious forms of pollution in the area; whether the situation is better or worse than in 1939; and whether the area is troubled by pollution drifting from other areas. In part II further processes are listed vertically. Across the paper are columns for their numbers, the number producing pollution, whether the pollution is due to coal, oil, pulverized fuel, or coke, whether it is smoke or girt. Examples of the processes listed are laundries, railways, dye works, potteries, and shipping. (APB)


An investigation of the nature and origin of smog in the Los Angeles County area, covering the period from June 2, 1947, to June 2, 1948, shows progress that has been made toward the solution of the problem, especially in these three points: (1) Development of the Standard Research Institute smog index; (2) evaluation of a forecasting method, predicting smog-free days with considerable certainty and smoggy days with at least 50 percent accuracy; and (3) preliminary laboratory tests of a number of suspected eye irritants which may be present in the smog, and development of methods for detecting and measuring low concentration of these and other compounds in the atmosphere. (APB)

Particular attention is given to the needs of underwriters, claim agents, accident-prevention engineers, and other occupants of the coal in use (and occasional need for information on the particular hazards). Therefore, the publication consists largely of a thorough review of the pertinent literature on the uses, occupational hazards, nature of the occupational disease, public liability, and products liability. Under the heading of public liability, cases of poisoning that occurred at some distance from a plant are discussed.


"All air pollution does not originate with the burning of fuel as much," the city council of Lansing, Mich., was told in the report of a survey on the problem in that city.

Entirely too much results from the burning of waste, refuse (and garbage), in fuel-burning furnaces or in inefficient incinerators. These practices produce not only smoke but objectionable fly ash, fumes, and odors. It is a well-established fact that, in the average industrialized city, almost as much weight of trash and refuse is burned in a year as the fuels that are consumed. The inefficient methods of consuming these waste materials cause much of the city's air pollution.

The conclusion was told that, while abatement of pollution in our cities was an engineering problem, the Coal Producers Committee for Smoke Abatement has always maintained that it also was a psychological one as well. You can be as free of pollution as you are willing to put forth the necessary energy and money to abate it.

A paper written in 1923 by Osborn Monnett for the Bureau of Mines shows that this phase of the problem was recognized at that time when he said, "The attitude of the public seems to be more important than the technical question involved. Committees get just as much law enforcement as they desire. Until the public is thoroughly roused, demands smoke abatement, and shows continued interest in it, no permanent improvement is possible. Smoke abatement is not a matter that can be settled overnight and then left to take care of itself without attention but is something that must be watched year in and year out if high standards are to be maintained."


The Bradford Corporation Act, 1910, and the Public Health Acts, 1926 to 1936, are discussed. The results of investigations into the causes of smoke in 449 cases of excessive smoke emission from various boiler installations are summarized. Eighteen percent of the cases were due to lack of enough draft-producing apparatus to meet fluctuating or peak load conditions; in the other 84 percent, the excess smoke was mainly caused by careless or faulty operation or negligent maintenance of some part of the boiler plant. The excess smoke that could be attributed to mechanical stoking was due primarily to the human element, in neglecting to adjust or regulate the throw of the stoker-shovels to suit the state of the coal in use (and occasional neglect to maintain the propelling parts for the moving firegrates in good order, so as to secure the full travel of the bars). The greatest single cause of excessive smoke was that due to heavy spread firing of coal on hand-fired furnace grates. (APB)


Although some of the restrictions on emitting pollution were relaxed during the war, there was no appreciable increase of smoke in the air. An increase in the deposition of ash was observed; this may be due to increased industrial activity combined with overloading of industrial boilers and furnaces, and the tendency for industrial coal to contain more ash. In agricultural districts the wartime effort to produce more homegrown foods had a noticeable, though small, effect on material collected in several rural deposit gages. The effect of ploughing grassland and of intensive cultivation was to increase the tendency for wind-blown dust to be collected. Although there was no marked and general increase of atmospheric pollution during the war, the improvement of atmospheric cleanliness was temporarily halted. Standards before the war were far short of perfection, and 5 years elapsed without any major attempts at improvement. The rebuilding and reconstruction offers many opportunities of improving the state of the atmosphere.


Pure air, where it is found, and the causes of its pollution are discussed.

Man has been contending with air pollution ever since he left the garden of Eden. He has survived because of his own defensive mechanism and because the movement of the air has diluted his various exposures to air-borne substances sufficiently to render them harmless, or at least tolerable. Owing to the enormous expansion of industry and methods of heating homes and offices man can no longer depend on the benign effects of nature to protect him.

Although pollution of the atmosphere by fumes and gases of industrial origin sometimes may give rise to a serious situation and can cause serious annoyance to large groups of people, the amount of disability and mortality from these causes is exceedingly small, so small that it could not be identified in any statistical tabulation of the causes of death or disability.


The smog of Los Angeles is unique in that it sometimes produces severe and disagreeable eye irritation. In common with the smog in other parts of the country, however, it also imparts murkiness to the atmosphere. Eye irritation is severe on some 20 occasions during a year, and then in only limited areas and for relatively brief periods. Reduced visibility in connection with smog occurs very much more frequently. The peculiar meteorology of the Los Angeles area appears to be decisive in controlling the time and duration of eye-irritating smog. Studies of meteorological influences have revealed an empirical correlation between certain meteorological factors and the time of occurrence of eye irritation from smog. This correlation gives promise of being useful as a means of forecasting such smog. The nature of the substances in smog that cause eye irritation is not yet known. Work on this problem is currently progressing by the invention of improved ways to collect and identify the particles that compose smog, and by determining, under laboratory conditions, the eye-irritating properties of these substances in various aerosol forms in a specially built smog chamber. (20 refs. are cited.) (Author's abs.)
AIR POLLUTION—A BIBLIOGRAPHY

333. MEETHAM, A. R. La Pollution atmospherique. [Atmospheric Pollution.] Meteorologie, ser. 4, 1949, pp. 1-17, repr.

Atmospheric pollution is due to solid particles, of large and small size, and to gases issuing from domestic or industrial chimneys. The nature of these impurities, and the methods and apparatus used for analyzing and measuring them, are discussed and details regarding their distribution in the atmosphere are given. (APB)


Findings in the Donora episode are described. The local industrial plants are indicated as being responsible for the episode, suggesting some of the irritant gases that could have given rise to the acute illnesses and fatalities. A plea is made for cleaner air, not only in this community, but in others in the United States. (USPHS)


Measurements of relative humidity in fog and stratus cloud frequently give values far below 100 percent, particularly in industrial areas. Drop radii measurements in the cloud show most frequent values around 7 μ in the occurrence of drops in equilibrium at a relative humidity of 90 percent would require solutions of concentrations of 17 percent for sodium chloride and 23 percent for sulfuric acid. Particularly in the latter case, that is, for combustion nuclei, this high concentration seems unlikely. The hygroscopic nuclei would be about one-half the size of the drop.

Visibility measurements, in conjunction with the humidity, give a means of estimating the relative contribution of hygroscopic and nonhygroscopic particles in obstructing vision, on the assumption that the number of hygroscopic particles is constant. The observations indicate that the latter assumption is not valid. Using a relationship between liquid-water content and visibility shown by Radford to fit observed data, a method is derived for determining the number and size of the hygroscopic particles, the value of the extinction coefficient due to nonhygroscopic particles, and the mass of the nucleus. Using the observations of humidity and visibility in Los Angeles Airport, and assuming that the nuclei are sodium chloride, these quantities are determined. The drop radii vary from 8 microns at 98 percent humidity to 3 microns at 67.5 percent, and the number decreases from 24 to 7 per cubic centimeter. (280 cc cited) (Author's abs.)


Petroleum refiners in the Los Angeles area, although their plants do not contribute to eye-irritating smog, have taken principal part in the smog relief program, through the Smoke and Fumes Committee of the Western Oil and Gas Association. Research departments of the individual oil companies initiated studies to determine the nature and extent of contaminants in the air. The research program was later expanded and transferred to Stanford Research Institute. In addition, the refiners took direct steps to minimize air contamination from sulfur dioxide resulting from refinery operations. The burning of sludge sulfuric acid was voluntarily discontinued. A program costing several million tons to recover sulfur from cracking gas if it is burned is expected to be in operation in 1949. (APB)


Overall report of the study of air pollution in Los Angeles, Calif. It contains a section on eye irritation, the one symptom that has caused the greatest degree of public clamor in that area.

It appears that eye irritation is most marked when the relative humidity is relatively low (25-30 percent), and is specially marked between 9 a.m. and 12 noon. Studies of incidence have been based on interviews with persons on the street.

A new contrivance was developed to assist in determining the causative agent. This involves a mechanism whereby irritant materials are introduced into a closed-goggle system, and the rate of blinking (blink rate) is recorded via the use of the interruption of a light beam noted by a photoelectric cell. A chamber has also been devised to hold persons whose senses may all be affected by the gas introduced into the chamber.

Thus far, the exact individual agent responsible for the irritation of the eyes has not been identified. It appears that the irritant effect is due to a combination of substances which may, possibly, have a greater action than only a summation effect. Thus far aldehydes, organic peroxides, elemental sulfur, and oil mists have been tested as possible causative agent. (USPHS)


After a section devoted to the general problems of industrial air pollution, specific types of pollution are discussed such as the pollution caused by beryllium wastes and by the toxic materials used in the uranium industry. The effects of various toxic materials are described.

339. WESTERN OIL AND GAS ASSOC., LOS ANGELES, CALIF. COMMITTEE ON SMOKE AND FUMES. The Smog Problem in Los Angeles County. 1949, 64 pp.

Progress in the solution of six problems concerning smog is recorded: (1) What contaminants produce it? (2) What is its meteorological mechanism? (3) What causes reduction in visibility? (4) What causes eye irritation? (5) What is the physical and chemical nature of the contaminants? (6) From where do the contaminants come? The principal contaminants are sulfur dioxide, ammonia, oxides of nitrogen, sulfur trioxide, aldehydes, and filterable oil, and a number of other named substances are often present. The haze would occur without human habitation, but is greatly increased by industrial processes. The following substances are mainly responsible for the haze: Car-}

bon and metals, 10 to 50 percent; (2) transparent, light-scattering crystals, 10 to 30 percent; (3) small, water-soluble and oil-soluble particles and oil droplets, small effect; (4) substances capable of forming moisture droplets, 5 to 20 percent; and (5) large, soluble crystals, 0 to 80 percent. (Percentages given apply to decrease in visibility.) At least nine substances capable of producing eye irritation have been identified, but no single one in sufficient quantities to cause the irritation. They include formaldehyde, ammonia, sulfur dioxide and trioxide, nitrogen oxides, acrolein, ozone, carbon particles, and oil. Work on the physical and chemical nature of the contaminants is proceeding, and they are shown to come from a great variety of sources. Methods and results of analysis, visibility studies, and research methods on the other problems, are described fully. Eight appendices give a variety of supplementary data and references. (IHD)


The discussion is limited to some of the major contaminants that may be released into the air in significant quantities and the processes and means of minimizing or controlling the problems.
Every refinery should make a complete study of its operations to determine the nature and extent of the contamination it may be contributing to the overall community atmospheric pollution load.

Reference is made to the research to uncover the factors that constitute the Los Angeles smog and determine in what ways the petroleum refining industry may be contributing to the problem. (7 refs. are cited)


Air pollution may result from the materials processed or from the fuel used in their processing in the metallurgical industries. The mills and furnaces of the steel industry are spread over 50 States with over 400 plants, making or finishing steel in 250 communities.

The atmospheric pollutants produced by blast furnaces, the open-hearth process, the bessemer converter, by-product coke plants, heating and reheating furnaces, and sintering plants and methods for their control are discussed. Progress that has been made in satisfying the requirements for metallurgical stacks as set forth in smoke control ordinance of Allegheny County, Pa., which became effective June 1, 1949, is described. (3 refs. cited)


The Coal Producers Committee for Smoke Abatement sounded a warning here recently that Toledo might not be able to reduce its air pollution unless its smoke clearance program is stepped up.

The local coal producers association was told that the biggest drawback is the fact that the local program has neither impetus nor wide public acceptance. The coal carriers and dealers, about 35 of whom attended the meeting, were urged to take the lead in combating air pollution. “If you don’t,” they were warned, “your competitors will.”

Another weakness in the local program has been lack of attention to repeated violators. After the proper warning periods and other correctional measures have been exhausted, repeat violators should be faced with some type of court action to force compliance with local ordinances.

More attention to the proper installation of heating equipment would also increase effectiveness of the program.


The valleys that embrace the major portion of the heavy industries of the United States are those in which air drainage and temperature inversions are prevalent. As the height of industrial chimneys rarely exceeds 250 feet, air pollution usually is excessive. The need is stressed for extensive micrometeorological research similar to that carried out at Trall, B. C. Conditions in Pittsburgh and their causes are discussed. Work done on the siting of chimneys in relation to air pollution is described. (APB)


In past years those interested in the fields of engineering, chemistry, plant physiology and, more recently, meteorology have met to consider new data gathered within their respective fields. They were not concerned with the health aspects of the problem. Nor, to any appreciable extent, was the medical profession. After the Donora catastrophe, however, came the deluge. Smog symposia became as frequent as parent-teacher meetings.

The situation is more serious than the tenor of the editorial can possibly convey. It points out that phobias, neuroses, and hysteria from fear of smog are on the increase. Even mass hysteria is not impossible.

The magnitude of the problem is tremendous, and it should be allied with the best university personnel and laboratory faculties.


The substances that pollute the atmosphere are divided into the following groups: (1) Solids: (a) dusts, (b) fumes, (c) smoke; (2) liquids: (a) Mists, (b) fogs; (3) Gases: (a) True gases, (b) noncondensed vapors.

Usual contaminants in city air are produced by the incomplete or improper combustion of hard and soft coal, liquid fuels, in furnace operations associated with iron and brass foundries, in oil refining, chemical operations, paper making, and miscellaneous activities. These are listed more definitely as follows: (1) Smoke, smoke, fly ash, and chemical dusts; (2) metallic fumes, such as iron and other oxides, zinc, lead, manganese; (3) organic matter, tar fog, oily constituents; (4) sulfur compounds including SO2, SO3, and sulfuric acid; (5) carbon monoxide and gaseous hydrocarbons from vehicular traffic, aldehydes and organic peroxides, fluorine compounds, chlorine compounds, ammonia, and oxides of nitrogen. Each is discussed.


Progress on the work on distribution of atmospheric contaminants is reviewed from 1935 to 1956. (18 refs. cited)


The report of the U. S. Public Health Service (Public Health Bull. 306) by the author, who made a brief investigation of the Donora episode. He believes that the data presented in that report indicates the “red oxide of nitrogen” to be the cause of the illnesses and the deaths. This was not believed by the Public Health Service investigators. Mills’ conclusion is reached by placing a theoretical “lid” over the valley and calculating the amount of gas that would accumulate during a given period of time. (USPHS)
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The lessening of eye and throat irritation caused by chemical wastes in atmospheric smog has been accomplished by Los Angeles during the past 2 years. The sulfur dioxide in the overcast condition known as smog is released by refineries, chemical plants, and the burning of fuel oil by other industries. The sulfuric acid, resulting from the oxidation of air in the sulfur chemical, is particularly irritating to human eyes and throats.

From gases that were formerly burned to produce 100 tons of sulfur dioxide in the atmosphere, sulfur is now being produced in one plant at the rate of 50 tons a day.

Control is by voluntary action on the part of industries, or by court action. Over 300 violators a month are being cited in the drive to eliminate Los Angeles smog.


The Donora study was the most intensive and exhaustive study ever made in the United States on air pollution, and was probably the most intensive effort ever undertaken by the Division of Industrial Hygiene. It represents the first time in the history of hygiene in the Public Health Service that a complete and thorough epidemiological study has been made of a particular air-pollution problem and the first time that almost every segment of the varied industrial hygiene staff has been drawn into such a major effort. In addition, the U. S. Weather Bureau cooperated in making the meteorological investigations.

Atmospheric pollution is no longer an optional field of activity—a fringe area of decided nuisance but of questionable health implications. The Donora study has erased any doubts that contaminants in the air can exact tolls on the health and life of people. Industrial hygienists, by their training, interests, and basic functions in the public health field, have no choice but to enter the field of atmospheric pollution, as they have attacked other toxic hazards.

The problem is too gigantic for any one agency to cope with alone. The operation will be a long-range one, and will require the efforts of physicians, engineers, chemists, and others.

371. WESTERN OIL AND GAS ASSOCIATION, COMMITTEE ON SMOG AND FUMES. The Smog Problem in Los Angeles County. 2d Interim Report by Stanford Research Institute on Studies to Determine the Nature and Sources of Smog. November 1950, 60 pp.

Progress made since publication of the Second Interim Report in 1949 is summarized. The problem is still far from solved, and yet the report testifies to much progress along several lines of investigation. There is a wealth of detail which cannot be summarized adequately in a brief review, but some of the highlights will be considered. The principal questions as now formulated are: (1) What is smog? (2) Why is there smog in Los Angeles? (3) What reduces the visibility? (4) What causes eye irritation? (5) Where do the air pollutants come from? (6) Where do we go from here?

The most noteworthy new information concerns the presence of an oxidant, or growth of oxidants, in addition to oxygen gas, in the atmosphere. The presence of this oxidant is established, and its quantitative determination is accomplished, by oxidation of potassium iodide in solution, after removal of interfering substances, in a most gratifying described in an appendix. Its concentration has been found to be higher in Los Angeles than in any other city studied. There is good correlation between the amount of the oxidant in the air and the extent of eye irritation, one of the objectionable features of the smog. Possibilities of its composition include ozone, organic peroxides, hydrogen peroxide, nitrogen oxides, and other chemicals. Of these, nitrogen oxides have been found to be present in quantities sufficient to explain a major part, but not all, of the oxidant effect observed. The presence or amount of ozone has not been definitely established because nitrogen oxides masquerade as ozone in all the tests that have been conducted. Hydrogen peroxide and organic peroxides have been found, but not in concentrations high enough to explain the oxidant content of the atmosphere. Tests of synthetic smog, and of smoke from burning various materials, showed that the gaseous products produced eye irritation and that absence of single gaseous ingredients did not materially reduce the irritation. Paper smoke was the most effective in causing irritation, along with loss of visibility. Progress was made on the identification and properties of particulate matter. Meteorological factors in smog production are considered in detail. One reason for the persistence of smog in the area is that in the absence of strong external winds, the light winds carry the pollutants toward the ocean at night without much dispersion, and then the day’s pollution sweeps over the city the next morning. Of the total combustion and evaporation products put into the air daily, about 40 percent comes from industrial sources and 60 percent from activities related to the home. The latter accounts for 75 percent of the organic materials, 65 percent of the aldehydes, 65 percent of the ammonia, 40 percent of the nitrogen oxides, 30 percent of the acids and 25 percent of the sulfur oxides, and the remainder in each case from industry. Thus Los Angeles smog is a community problem, not one for industry alone. It can be abated only by community action. (PHEA)

1951


Solution of the problem of complaints regarding incinerators and backyard trash fire burning is discussed. In connection with incinerators several methods are suggested such as to discontinue their use or rehabilitate the units or install different type of unit. It is concluded that the only way to overcome the nuisance of trash fire burning is to make the burning of the fire illegal.

373. CANADIAN MINING JOURNAL. At Random, Vol. 72, 1951, p. 46B.

We have all heard of “smoke farmers” who have sought to receive compensation from smelters and other metallurgical plants for damage caused to their crops by waste products delivered to the atmosphere. For an account of what may well turn out to be an atheistic case we are indebted to Asbestos, a trade journal serving the asbestos industries.

On the island of Cyprus there is a flourishing wine and spirit industry, based on the extensive and excellent vineyards that cover most of the slopes of the mountains up to an elevation of about 4,000 feet. Here, at about this height that the asbestos mines are situated, and clouds of dust stream from them, they are carried by the prevailing winds into the valley to the south. Here the dust settles on the vines, and both fruit and foliage are covered with a thick layer of this very fine, gray dust, though at no apparent detriment to the quality of the grapes. As is the case of most good things in this world, the vines are subject to parasitic attack, and some of them cause a peculiar form of powdery mildew, to guard against its onslaughts it has been the custom to dust the vines with flowers of sulfur. During the late winter and spring, when no sulfur was available and heavy damage was caused by the mildew all over the island, except in the valley south of the asbestos mines, where the plants were almost entirely unaffected.
Rumor went the rounds to the effect that the dust from the asbestos mines protected the vines and grapes, and a brown powder was obtained on the island and asked for a supply. At the present time the Government of Cyprus is conducting extensive experiments, and its report will be very eagerly awaited, as it may well confirm the turning of yet another waste into a useful byproduct.

374. CHEMICAL AND ENGINEERING NEWS. Read This and Weep, John Q. Vol. 29, 1951, p. 844.

The smog-bedecked public out Los Angeles way should have cleaned up its own yard before blaming industry for its troubles. Biggest single source of organic chemicals entering the air is household burning of 4,000 tons of trash every 24 hours. So says Stanford Research Institute at conclusion of latest survey on the smog problem. Of the total materials thrown into the atmosphere 60 percent come from activities of the general public. Industries in the area account for the remaining 40 percent. Principal cause of smog: Incomplete combustion of nearly 50,000 tons of fuels and rubbish daily. These emit 2,250 tons of chemicals, about two-thirds organic, which by reaction and combination cause eye irritation, poor visibility, other smog effects.


Unsaturated hydrocarbons are credited as being the principal causes of eye irritation, crop damage, and reduction of visibility in the Los Angeles area. Hydrocarbons are included in the class of "organics" without indication of the fraction that might be objectionable contaminants. Authorities do not agree on the amount of hydrocarbons reported lost from refinery operations. It has been pointed out that any estimation of the contribution of a pollutant to the total smog effect should take into consideration the pollutants known to be irritating, and also those that can be transformed into irritants under the conditions existing in the air. Harmless pollutants, or those that are easily converted into harmless compounds, should not be included in a survey of smog sources.


The effluent from wire-enameling ovens contains several ingredients which are irritating even in small concentrations and are a contributing factor in the atmospheric pollution problem. The results of tests described in detail indicate that catalytic combustion of the effluents can greatly reduce the atmospheric contamination and escape of combustible materials. The general method of catalytic combustion should have possibilities in control of atmospheric pollution wherever the contaminants are combustible or readily oxidized to less irritant compounds. Each installation should have chemical and physical tests made on the oven and stack effluents in order to determine the optimum operating conditions and verify the reduction of the contaminants. A minimum of instrumentation should be necessary for indicating the continued activity of the catalyst. The entire project is still in the experimental stage, and additional tests are being conducted. (AIHOM)


The problem of atmospheric pollution has required some attention by the Bureau of Industrial Hygiene. Several stations have been maintained to determine the total amount of particulate matter that is deposited during various seasons of the year. The laboratory analysis of specimens from these stations indicates that a total fall of 100 tons to 800 tons per square mile per year has occurred in parts of the city of Honolulu other than those set aside for industrial purposes. By chemical analysis of the samples, the probable source of the pollutants was determined. Following the volcanic eruption that occurred on the Island of Hawaii in June 1950, a dust cloud blanketed the city of Honolulu and was visible for many miles at sea. A mild hysteria resulted as rumor suggested that the dust was a radioactive cloud released by an unfriendly power. An investigation conducted by the Bureau determined conclusively that the dust cloud was of volcanic origin.


An opalescent darkening of the sky began on March 25, and the haze was strongest on March 27. The sky showed an unusual bright-yellow color at sunset; at night dust accumulated on the windward side of objects, and its thickness was so great that it resembled hoar frost. The dust consisted of soil salts and clay particles. The visibility was reduced. Although air from the dry steppes of Kazakhstan had occupied the area from March 17 to March 25, the characteristics of the dust indicated that the haze was not due to this air. (APB)


In Los Angeles, Calif., the most disagreeable effects of smog are numbness and irritation of the eyes, noses, and throats of the inhabitants. The most apparent economic effect is the damage to certain crops. Combustion products contribute materially to the atmospheric impurities. Approximately 50,000 tons per day of fuel and rubbish are burned in Los Angeles County. Public and industrial burning of these materials emits to the area each day at least 1,800 tons of these impurities, not including carbon monoxide. Household burning of 4,000 tons of trash, the biggest single source, sends 550 tons of organic materials into the air every 24 hours. Approximately two-thirds of the chemicals entering the air from combustion are organic in nature. Exhaust fumes from approximately 2,000,000 automobiles, buses, and trucks in the county, which drive an average of 50,000,000 miles a day, contribute another 350 tons of organic substances, as well as 30 tons of hydrocarbons of pollution of nitrogen oxides. Detailed data are presented showing the sources of the various impurities and the quantity each source emits. (2 refs. cited) (Authors' summary)


Control experiments carried out by California Institute of Technology, to test the theory that the hydrocarbons in the air could be oxidized to produce compounds damaging to plants and causing eye irritation, have proved that catalytic action of nitrogen peroxide with light plays an important part in the origin of air contaminants. (APB)


For the past several years most residents have pointed to refineries in the vicinity of Los Angeles as being the major cause of the city's smog problem. It turns out now that all along the accusers themselves have been the worst offenders. This conclusion was announced here last week by Stanford Research Institute on completion of a year-long survey sponsored by the Western Oil and Gas Association. The survey, undertaken to determine sources of combustion products and measure their im-
portant chemical constituents, added specific data to earlier general findings.

Burning by the public and industry of nearly 50,000 tons a day of fuels and rubber is thought to result in at least 2,280 tons of chemicals being emitted into the atmosphere. Of this total, 60 percent is believed to come from activities of the general public, such as driving automobiles and buses, burning garden trash, and heating homes, stores, and office buildings. All industries in the county account for the remaining 40 percent.

Organic sources.—Almost two-thirds of the chemicals entering the air are organic in nature, Institute scientists said, and 76 percent of these organic chemicals are produced by activities of the general public. Household burning of 4,000 tons of trash, the biggest single source, alone sends 250 tons of these organic materials into the air every 24 hours.


The California oil-refining industry, which in recent months has been given a more or less clean bill of health by control authorities, again has been indicted as a major cause of the Los Angeles smog problem.

This time the charge is twofold: First, vapor losses from gasoline-storage tanks and vaporization during delivery of gasoline via truck and pump; and second, the huge volumes of unburned gasoline vapors from the exhausts of automobiles and trucks.

Two years ago refineries in the Los Angeles Harbor area were accused of being the major contributor to the visible bluish smog which rolled over the area during periods of temperature inversion. Then the emphasis was on sulfur dioxide as being the element that caused eye smarting and crop damage.

At a cost of several million dollars for installing equipment to remove all sulfur dioxide from their waste gases, the refineries have virtually eliminated this source. The benefits of the program were felt during the past war, when there were fewer onsets of visible smog. Likewise gas-testing equipment of the Los Angeles County Air Pollution Control District showed a marked reduction of SO₂ in the atmosphere.

But the eye-smarting and crop-damaging attacks have continued. Likewise so have the efforts of the control group to pin down both the cause and source of the smog attacks.

Tests in large have shown that unburned gasoline products from the exhausts of automobiles are an important factor. Tests on gasoline storage-tank losses and other vapor losses are incomplete but evidence has been obtained which also points to raw gasoline.


Rapid growth of the population of many western cities has focused attention on periodic murkiness of the atmosphere. Much publicity has been given to the Los Angeles smog. A 3-year study by Stanford Research Institute indicated that the daily burning of nearly 50,000 tons of fuels and rubber is the principal cause of the Los Angeles smog. Research shows further that this burning by the public and industry emits to the air each day at least 2,280 tons of chemicals which can cause poor visibility, eye irritation, and other smog effects. The community aspects of air pollution complicate the means of abatement. Significant pollutants are emitted from automotive engines and backyard incinerators, as well as from industry. Industry's responsibility to the community makes it necessary that its house be in order. It is good public relations to be a good neighbor by abating nuisance effluents. Enlightened management will regard potential air pollution as an important factor in plant location. A scientific study of wastes discharged to the air and their dissipation by meteorological conditions may save some of the cost of corrective equipment. Air-pollution regulations are becoming more stringent. Only scientific study and industrial cooperation can insure intelligent legislation concerning air-pollution abatement. (AIHOM)


The author points out factors that constitute air pollution or make it nuisance; it can come from domestic as well as industrial sources; it can diminish sunlight; it can cause toxic effects in humans and animals through either the respiratory or digestive system. Plants are sensitive to it. A case of damage to rare herbs by SO₂ is cited.

Contaminants are classed as (a) gases and vapors and (b) particulate matter (dusts, fumes, smoke, and mists—a descriptive table is given). Variety of pollutant effluents is stressed.

Evaluation divided into Study of “pollution sources and their magnitude,” and “measures of dispersion and area contamination.” There is a discussion of sampling devices and particle collectors with some comments on the relative merits of the different ones.

The use of “tracers” added to effluents to determine if a plant is a source of contamination is suggested. (PHEA)

1952


The Consolidated Edison Co. of New York City has been receiving public censure for its stack emissions.

Con Ed furnishes a classic example of the complex problems involved in controlling air pollution, as well as in the general lack of public understanding of these problems.

Eight million persons need electricity, gas, and steam service in New York. Without them the city could not function. Con Ed supplies these services and thus furnishes a considerable number of creature comforts to the population of the second largest city in the world.

One company alone accounts for a consumption of about one-third of all the fuel used in the city. This third is equivalent to 10,000,000 tons of coal a year, made up of 7,000,000 tons of coal plus oil and natural gas equivalent to 3,000,000 tons of coal.

Although the company is the largest single user of fuel in the city, it is emphatic in claiming that it is not the major source of air pollution. It further points out that, even after its program is completed, reduction of citywide air pollution will not be significant unless the other various sources of pollution are likewise reduced.

Some of the measures being taken to solve the problem are outlined. The engineers of Con Ed estimate that the amount of fly ash and soot from the stacks has been reduced probably as much as 93 percent.


Gob piles consist of refuse accumulated during coal mining and preparation operations.

Years ago scant attention was paid to these piles. At the best they were eyesores, at the worst, when ignited, they gave off acidic odors and undesirable smoke. Pyrotechnically they were often quite attractive and were pointed out to visitors making their nocturnal rounds of the district.

There are 20 to 25 such piles burning in Allegheny County at present and literally hundreds of others that may fire at any time. The county also has numerous records of piles that have been dormant for as long as 20 years and that, for no discernible reason, suddenly ignite.

A Western Pennsylvania Coal Operators' Association (an AP & SPIAA member), established a fel-
lowship at Mellon Institute 2½ years ago for the purpose of studying the control of gob piles and of making recommendations concerning them. The investigation, headed by Dr. William L. Nelson, is important and complicated. The School of Mineral Industries at Pennsylvania State College is also undertaking a study, and two gob-pile committees, formed by the Western Pennsylvania Coal Operators' Association and the Central Pennsylvania Coal Producers' Association (an AP & SPAA member) are coordinating their activities. Progress is being made, but a foolproof solution has not yet been presented.


Causes of Los Angeles smog and A. J. Haagen-Smit's theory based on oxidation of unsaturated hydrocarbons are discussed. Preventive steps taken by the oil industry, criticized as the main contributor to smog, are described. Although more is known about smog than in 1946 when research on the problem began a solution seems no nearer. (APB)


Reports on spoilbanks and the emission of dust and smoke by power stations and industrial steam-raising plants are included. At Battersea power station sulfur removal represented 50 percent of the coal burned. In the section on coke ovens, the prevention of smoke emission during charging and discharging of retorts is discussed and statistics are given for the production of ammonia, tar, and sulfuric acid. (APB)


Combustion products contribute materially to the atmospheric impurities. Approximately 50,000 tons a day of fuel and rubber are burned in Los Angeles County. Public and industrial burning of these materials emits to the area each day at least 1,800 tons of these impurities, not including carbon monoxide. Household burning of 4,000 tons of trash, the biggest single source, sends 550 tons of organic materials into the air every 24 hours. Data are presented showing sources of impurities and quantity each source emits. (APB)


The Haagen-Smit hypothesis of the nature and cause of the Los Angeles smog was called to the attention of refiners at the meeting of the Refining Division of the American Petroleum Institute in Los Angeles. Although this is said to be a new and as yet unproved theory, refiners are warned that they had better check their own refineries. This theory will focus attention of pollution-control boards, politicians, and the public directly on the refineries.


Some of the potentially harmful waste materials in the laboratory and production operations of the United States Atomic Energy Program may be chemically toxic, while others are radioactive. The waste products of significance to a group interested in air pollution are in the form of particles, fumes, mists, and/or gases resulting from: (a) Gaseous reactor effluents resulting from the use of air for cooling purposes; (b) chemical dissolving and separation process; (c) operations of "hot" laboratory hood; (d) dusts and fumes from processing of ores and metals; (e) incineration or high temperature destruction of contaminated solid materials, experimental animals, etc.


The problem of handling waste debris from mines and the possible effect such material could have on the local community and areas where mine refuse exists is most serious especially at places where some of the larger operations dispose of as high as 3,000 to 4,000 tons of waste material per operating day or as much as a million tons a year. Where such piles are on fire the smoke and gases emanating create a serious air-pollution hazard.

Waste material from coal mines with its carbonaceous matter and sulfur content is considered specifically. Review is presented of studies now being made on mine refuse piles and means of preventing the fires resulting from same.

AUTOMOBILE EXHAUST

1919


Experiments were made in a garage with an automobile whose engine was run at various speeds. Only information regarding poisoning due to carbon monoxide is given. Eye smarting and eye watering and illness were experienced. Although aldehydes are not mentioned, it is quite probable that these were responsible for at least a part of the effects. (CLAC/UCLA)

1924


Describes extensive tests to determine whether persons operating machines using ethyl gasoline were in danger of poisoning from the tetraethyl lead in the fuel.

1927


The observations by Florentin relate to the presence of CO and CO2. The former was estimated by the "blood method" described by himself and Vandenbergh. The air in those streets where there is much motor traffic shows slight increases in CO content and notable increases of CO content; the amount depends upon atmospheric conditions, an increase from less than 0.01 liter per cubic meter up to as much as 0.045 liter in still weather being observed at times. The increase is greatest at ground level and does not extend to the third floor (troisième étage). Air for ventilation systems should be drawn from this level. The air in the suburbs is much less polluted than that in the center of Paris. A table shows the results of 27 analyses. (BH)

1928


Exhaustive technical study of the concentrations of carbon monoxide gas at busy intersections and auto
repair shops and in buses in 14 large United States cities is reported. Street samples, taken under the worst possible conditions in regard to carbon monoxide content, showed 1-2 parts per million. Repair shops showed 100-1,000 parts per million.

It is concluded that concentrations encountered on streets are not hazardous. The same conclusion is drawn for buses, except where an exhaust leak may occur. It was suggested that policemen stationed at busy intersections may be subjected to toxic doses over an 8-hour day for a cumulative effect. A real hazard apparently exists in repair shops, even when ventilated, as concentrations frequently exceed allowable maximums. The only adequate remedy appeared to be ventilating the exhaust by a hose attached to the tail pipe and restricting motor operation to 30 minutes. (USPHS)


A further contribution on the content of carbon monoxide of the air of the streets of Paris. It was found usually to be below 1 part in 100,000 and to rise to the highest tested at the time the samples were collected. The amount rose to 10 parts in the most frequented streets and in particular at points where the traffic is held up by police control and the engines of motor vehicles are running. Despite the immense increase of motor traffic in Paris, the amount of CO in the air was found hardly to exceed the amount fixed by Albert Levy in 1877, namely, 32 parts per 100,000, the largest amount found being 60 parts per 100,000 at a point where 2,000 vehicles were passing per hour. (BH)


An investigation was carried on in Chicago where in 690 street-air samples were collected and tested for carbon monoxide content. The distribution of samples by concentration brought out three types of streets: Residential and industrial; traffic and carline; and motorcar boulevards. The boulevards had approximately twice the air pollution of the traffic streets, and four times that of the residential and industrial streets. A definite correlation was found between the number of motorcars passing at the time the samples were collected and the amounts of carbon monoxide found to be present. When no car was passing for 5 minutes the carbon monoxide was as low as 0.1 part per 10,000. Twice as high concentrations, as coinciding with the morning and evening rush hours. The concentration for such times is enough to menace the health of anyone exposed for several hours to such an atmosphere, particularly if his activities call for deep and rapid breathing. Further studies are required to determine the concentration of carbon monoxide in the blood of such persons, and the presence of any injury to health. It is recommended that idling of motors on streets should be restricted to a minimum, and it is pointed out that the whole question is one of increasing importance. (BH)

1930


This investigation was undertaken because of the increasing number of accidents due to inhalation of exhaust gases emitted by petrol- and benzol-driven motor vehicles.

Full details are given of: (1) The chemical analyses of the exhaust gases, the apparatus used (with illus-

trations) and the conduct of the experiments; (2) the toxicological experiments; and (3) the practical tests as to the amount of CO, CO₂, CH₄, etc., present in over 100 street blocks, tunnels, and restricted areas.

Naturally, comparison is always made between conditions of the most perfect combustion and the most perfect action of the engine (at full load) and those much less satisfactory when the car is stationary with the engine running.

The general conclusion reached—in striking agreement with that arrived at in the Final Report of the English Ethyl Petrol Committee—is that carbon monoxide is the only gas with acute action given off. In consequence, however, of the extraordinary rapidity of dilution, the CO concentration in the atmosphere at breathing level rarely exceeds 2 parts per 10,000, so that risk to the general public is to all intents and purposes absent. In 95 of the 101 tests the proportion of CO was under 1.5 parts per 10,000. The highest was 2.7 which, it is said, closely corresponds with observations made by investigators in the United States. The highest proportion found by the Ethyl Petrol Committee was 1.7 parts per 10,000, but when taken, the sample bottle was quite close to the exhaust.

Inhalation of a proportion of 2 parts per 10,000 if continued for hours together must lead to some saturation of the blood by CO and symptoms of headache, dizziness, and palpitation precautions are called for in the case of police on point duty in places where “hold-ups” are frequent, and in garages and repair workshops. (BH) 1938


Attention is also drawn to the atmospheric pollution caused by automobiles. Exhaust gases may contain as much as 10 percent of carbon monoxide. People living in ground-floor or first-floor apartments in busy thoroughfares are exposed to these fumes and suffer malaria when their windows are open, but are unaffected when their windows are kept closed. (BH) 1943


To reduce objectionable fumes and odors in exhaust gases a gasoline-base motor fuel is blended with about 0.5-5% of an alkyl amine, as ethylamine, and with 0.005-0.2 percent its weight of an alkyl nitrate containing 3, 4, 5, or 6 C atoms per mol, for example, An NO₂. (CLC/LCLA) 1948


The danger of carbon monoxide poisoning among men working on gasoline-driven vehicles is emphasized. A concentration of several thousand parts per million may occur in the air near the exhaust outlet, even outdoors, unless exhaust gases are discharged so that the carbon monoxide is diluted before it can return to any area where it may be inhaled. Symptoms, which usually occur with the carboxy-haemoglobin content of the blood reaches 20 percent, include headache, dizziness, faintness, nausea, and vomiting. Samples of exhaled blood should be analyzed for the presence of carbon monoxide as soon as possible after exposure, to minimize reoxygenation of carboxy-haemoglobin, but they can be frozen and sent to a laboratory. The presence of a significant amount of carbon monoxide in the blood will differentiate symptoms due to carbon monoxide poisoning from those due to other causes, especially alcohol. Heavy cigarette smoking may produce carboxy-haemoglobin levels up to 10 percent. (API)

The composition of exhaust gases and their toxicity depend on a number of variable factors, but CO is the principal deleterious constituent that occurs in toxic concentrations; others (unsaturated hydrocarbons, aldehydes) are present in too small proportions to affect health. With increasing motor traffic, the toxic concentration of CO may spread beyond the line of traffic to the vicinity of main roads. Indirect effects also have to be considered, for example, absorption of UV rays and sunlight, disagreeable odor that favors superficial breathing, etc. The remedy lies in (1) insuring the most complete combustion possible by proper engine design, adjustment of carburetors to poor mixtures with frequent inspections and overhauls, especially of nozzles, use of high-grade fuel with frequent quality and purity tests; (2) care in avoiding fuel and exhaust leaks, smoke due to oil splashes, insuring proper compression, fitting tractors, buses and trucks with gas absorbers and electrostatic filters; (3) regulations to concentrate main flow of traffic over wide roads with pedestrian traffic at a safe distance, keeping cars, garages, etc., away from narrow streets and congested districts; (4) available official control to insures observance of all these points. (FA)

1950


Probably the most frequently encountered atmospheric pollution is that from buses and trucks. The sickening fumes associated with bus riding, the obnoxious odors coming through automobile fresh-air heaters, and the burning sensation in eyes and nose at certain traffic intersections are typical examples of exposures to bus and truck exhausts. This pollution is extremely obnoxious and disagreeable and causes a feeling of illness and nausea in some individuals.

On busy city streets it is possible the carbon monoxide content of the air may exceed the maximum allowable concentration of 100 parts per million parts of air. However, as this concentration is based on an 8-hour exposure, the average citizen will not suffer discomfort or ill health.

With regard to the other substances, such as aldehydes, present in exhaust gases, tests indicate that 0.1 part per million aldehydes in exhaust gases is offensive and irritating to some individuals. It is suggested that scrubbers can be utilized to reduce the aldehydes below offensive levels.

1951


Exhaust fumes from the approximately 2,000,000 automobiles, buses, and trucks operated daily in Los Angeles County which are driven an average of 50,000-60,000 miles a day contribute another 250 tons of organic substances as well as 30 tons of irritating aldehydes and 40 tons of nitrogen oxides. The latter chemicals, as oxidizing substances, were described as important reactants for further combinations in the atmosphere.

Exhaust of such of the organic material in automobile exhausts consisting of burned and partly burned gasoline, it was disclosed, and approximately an equal amount of gasoline vapors—400 tons—escapes by evaporation. Of this latter total, it is estimated that about 250 tons are lost from refinery operations while 175 tons are lost from automobile gas tanks and service stations.

1953


The advantages of the oil burner for heating the house are considered. The different methods of home heating are listed in order of choice as follows: Electric, oil, gas, coal, wood, peat. The advantages and disadvantages of each are discussed. About the only disadvantage of electricity and gas is the high cost. Oil, although somewhat more expensive than coal, offers many advantages over the latter. With oil there are no dirt, ashes, or smoke. The efficiency of the oil burner is higher than that of the coal-burning heater, and the "service rendered by a good burner is beyond belief to those who have not looked into the matter."

1939


Oil heat is considered from the smoke-prevention viewpoint. The object is to determine the characteristics in a liquid fuel and the features in the manner in which it burns that tend to make its combustion smokeless and inoffensive.

Progress in the intelligent use of fuel oil in metropolitan centers will tend greatly to reduce the smoke nuisance.

1940


It is only through thorough understanding of the characteristics of the various fuels and the different types of mechanical fuel-burning equipment that a satisfactory smoke-elimination program can function successfully.

Practical field experience, intensive research, and improved manufacturing developed better equipment and improved installation methods, which have materially increased the efficiency of oil-burner operation and reduced the cost of heating with oil.

An oil burner is a mechanical device to bring air and oil into intimate contact ready for the combustion, which takes place in the combustion chamber of the heating unit.

The following four main classifications of oil burners are described: (1) Vaporizing, (2) vertical rotary, (3) gun type, (4) horizontal rotary.

1943


Problems presented by the greatly increased consumption of fuel oil and transportation difficulties incident to the prosecution of the War are considered. Some of the projects completed or contemplated should help relieve the oil shortage.


Reference is made to the challenge due to the war emergency which caused conversion of thousands of oil-burning plants, free from smoke emission, to solid fuels which are vulnerable to smoke emission.
In attempting to meet the requirements of this conversion, many plant owners seem to think the change is only temporary and are making installations on this basis, with smoke trouble as an immediate experience. Methods of meeting the usual smoke-prevention requirements in these conversions are discussed. The steam-air jet, properly designed and applied, is said to be a most effective tool.


Problems and difficulties experienced by the oil industry in meeting the war and civilian requirements for oil and how they were solved are presented.

1945


Oil heat is considered from the smoke-prevention viewpoint. The requirements of smokeless operation of oil burners depend upon the selection of the oil, the selection of the burner, and the installation of the combustion apparatus, of which the oil burner is only one component part. These points are discussed briefly.

1947


Resposibility for clearing the air of our cities from pollution due to the combustion of petroleum products lies with the refiner, the manufacturer of equipment in which these fuels are being used, and the operator; the extent to which each is involved is analyzed. Requirements for complete combustion of a liquid fuel in four consecutive stages are given, and, in each stage, the factors that interfere with the completeness of the process are discussed to determine how the responsibility for their correction should be divided. (APB)


To abate any smog conditions at its Torrance, Calif., refinery, General Petroleum Corp. developed a system for burning waste gases by using a venturi-type aspirating burner for burning isobutane vapors for example; a ratio of venturi throat area to gas-orifice area of 4 to 1 was found adequate; with up to about 20 percent of unvaporized hydrocarbon in the gases it was found necessary to increase this ratio to 16 to 1. Flames did not "pop back" to the gas orifice at gas pressures as low as 1/4 p. s. i. g. A series of burners of different sizes were installed, controlled automatically to go into and out of service as gas pressure varies. The installation has been satisfactory in eliminating smoke nuisance. (APB)


The Minister of Fuel and Power was asked what special steps will be taken to prevent oil smoke from the new Bankside power station interfering with the view of St. Paul's. Mr. Gaitskell: In giving their consent to erection of the new stations the Electricity Commissioners will stipulate that it should use the most efficient methods for eliminating smoke. The details of this requirement will be settled in agreement with the Ministers of Health and Works. Moreover, any emission of black smoke would be subject to the smoke-nuisance provisions in the Public Health (London) Act, 1936, and smoke bylaws made by the London County Council. (APB)


The Minister of Town and Country Planning was asked whether he has received authoritative expert evidence on eliminating smoke from the newly-built Bankside generating station and whether he will publish his evidence. He was asked (1) what steps he is taking to satisfy himself that no noise and sulfur or other noxious fumes will be given out by the proposed electricity-generating station on Bankside; (2) what reports he has received on the possibility of eliminating sulfur and other noxious fumes emanating from oil-fired electricity generating stations; and (3) if he will make a statement thereon. He replied that he was satisfied from the advice received that sulfur and other noxious fumes can be eliminated. To insure that the design of the plant to be installed is satisfactory, a pilot gas-washing plant is to be constructed, and, when the results of this are available, the Electricity Commission will consult with the Ministers of Health and of Works. As regards noise, the Electricity Commissioners imposed a condition in giving their formal consent that the undertakers shall provide efficient methods of avoiding noise, and there is no reason to think that any difficulty will arise. (APB)


In giving their consent to the erection of the Bankside power station, the Electricity Commissioners will stipulate that it should use the most efficient methods for eliminating smoke. The details of this requirement will be settled in agreement with the Ministers of Health and Works. Any emission of black smoke would be subject to the smoke-nuisance provisions in the Public Health (London) Act, 1936, and smoke bylaws made by the London County Council. (Parliamentary Secretary, Ministry of Fuel and Power.) (APB)


Experiments are described that have been made to use some form of brick arch arrangement to improve combustion and obtain the highest possible efficiency with oil-burning steam locomotives on the Santa Fe Railroad. Dutch ovens were found to be superior to the early brick designs in performance and endurance. Both systems are explained, and some of the few disadvantages of the dutch-overy type are mentioned. Correct alignment of the oil burners is essential, especially if the oil flame strikes the side of the oven; it creates creosote, depletes the flame, and produces unsatisfactory results. There is also a tendency for greater drumming and gassing and heat is retained in the firebox for several hours, which makes it almost impossible to perform ordinary firebox repairs without considerable delay. (FA)

1948


Tells how automatic systems using photo cells and relays have virtually eliminated smoke and resulted in fuel savings of almost 20 percent on oil-burning boilers of Harvey Hubbell, Inc., Bridgeport, Conn. (APB)


A letter to the editor states: In announcing on May 19, 1947, that oil, not coal, would be burned in the Bankside Power station, and that sulfur by-products would be installed to eliminate sulfur, the Lord Chancellor said: "If we find that there is a danger that these difficulties may not be surmounted, then I agree that is a real argument against the scheme. In our discussions I was told that sulfur could be effectively
eliminated. I agree that this is a sine qua non of the scheme." On February 5, 1948, the Minister of Fuel and Power was asked whether he would confirm the above assurance, replied, "Yes." As late as September 23 last, in answering a question of which due notice had been given, he did not challenge a statement therein that the Government was pledged not to proceed unless oil fuel was found not to be harmful to buildings near by. He added that the result of the promised test of methods of eliminating sulfur would not be available before the spring. On November 18 the Minister would not promise that if no way was found of making the fumes harmless to St. Paul's the project would be abandoned. Thus repeated and unconditional ministerial guarantees have been thrown overboard, and those whom they lulled into a sense of security have now to be content "because of the increasingly urgent need for new generating capacity," with an assurance that "there is no doubt about the practicability of eliminating the fumes." (APB)

421. LONDON TIMES. Bankside Power Station. 1948.

The Minister of Fuel and Power was asked on what grounds the erection of the new Bankside power station is to proceed when the results of the tests being undertaken to discover whether it would emit fumes harmful to the fabric of nearby buildings would not be available till early next year. As the Minister of Town and Country Planning explained last year, the Government's technical advisers are satisfied that harmful sulfur fumes can be eliminated effectively. The tests on the plot plant are solely for the purpose of selecting the most efficient method of gas washing. View of the increasingly urgent need for new generating capacity in London, it is only sensible, therefore, to proceed as quickly as possible with the erection of these parts of the station that will not be affected by the type of gas-washing plant it is decided finally to install. The Minister was asked whether he would give a promise, in accordance with the previous pledge in the House, that if no way is found to make the fumes of this oil harmless to the fabric of St. Paul's the project will be abandoned? The Ministry of Town and Country Planning made it perfectly clear that there is no doubt about the practicability of eliminating the fumes and that it was only a question of the best way of doing this. As the Minister's statement was said to be a flagrant breach of the Government promise the matter would be raised later. (APB)

1949


In answer to an enquiry in Parliament as to whether buildings could be satisfactorily protected against the effects of harmful and noxious fumes emitted from oil-burning plants, the Minister of Fuel and Power stated that harmful sulfur fumes could be effectively eliminated. (FA)


Intensive experimental work is in progress to ascertain the possibilities of using powdered coal in place of oil as the source of energy for gas turbines. (FA)


Petroleum refiners in the Los Angeles area, although their plants do not contribute to eye-irritating smog, have taken a principal part in the smog-relief program through the Los Angeles Smoke and Fumes Committee of the Western Oil and Gas Association. Research departments of the individual oil companies initiated studies to determine the nature and extent of contaminants in the air. The research program was later expanded and transferred to Stanford Research Institute. In addition the refiners took direct steps to minimize air contamination from sulfur dioxide resulting from refining operations. The burning of sludge sulfuric acid was voluntarily discontinued. A program costing several millions to remove sulfur from cracker fuel gas before it is burned is expected to be in operation in 1949. (FA)

1950


Improvement of flare tips, which has been effected by the engineering departments of refineries, has been an important phase of the program for better control of the disposal of plant wastes. In general, the conditions at the plant and the surrounding neighborhood determine the type of disposal system that is installed. Some companies employ stacks, others burning pits where ground space is available. The record shows that smog has not been a product of petroleum processing. (HID)

1952


The three basic fundamentals of oil burning necessary to prevent oil smoke in commercial applications are discussed in detail. These fundamentals are (1) atomize the oil thoroughly; (2) mix air intimately and turbulently with the oil and flame; (3) control the air-oil ratio. If these fundamentals are blended properly burners in commercial boilers will be efficient and smokeless.

RAILROAD LOCOMOTIVES

1887


1884


Detailed explanation of a form of firebox to overcome the objectionable results usually arising from the use of soft coal to generate steam in engines, especially on long runs.

An interesting description is presented of a trip made to Albany on the Chicago limited in the cab of an engine equipped with this smoke-preventing appliance. During the whole trip, close attention was paid to the firing and sparks and smoke. After the engine had been working hard, when steam was cut off, there was no indication of smoke. This appeared to the viewers to be better than the best smoke-consuming locomotives ever seen in Europe.

1898


A public nuisance is defined to be a crime against the order and economy of the State and consists in unlawfully doing an act or omitting to perform a duty which act or omission annoys, injures, or endangers the comfort, repose, health, or safety of any considerable number of persons or renders them insecure in life or the use of property.

The charge directed against the Long Island Railroad is that in operating its railroad within the city limits it has used soft coal to the prejudice of the health and comfort of the neighborhood.

The development of case law and statutory law in defining and protecting the rights of the individual is nowhere more marked than in the law of nuisances.
1900


This is a treatise in question form for engineers, firemen, and others interested in fuel economy and suppressing smoke from stationary steam-boiler furnaces and from locomotives. The object is to teach firemen and engineers a better and more rational method of firing leading to abatement of the smoke nuisance.

Much collateral information, not always bearing on furnace combustion, is presented in the belief that such information will be helpful and gladly received by those wishing to acquire a broader knowledge including all the facts relating to the subject of combustion in general.

1901


Letter showing progress and describing methods of regulation. (MIR—Bib.)

1902


With reference to locomotives. The system of "single-shovel" firing, as laid down by Sinclair in his booklet "Burning soft coal without smoke," has produced good results. (MIR—Bib.)

1904


Bituminous coal must be used, and no legislation can prevent it. Other fuels are in limited supply. Smoke abatement is possible; prevention of injuries from air pollution is not. This abatement may be made the source of profit.

Black smoke is due to hydrocarbons in the fuel that were not consumed owing to lack of oxygen. The hydrogen is burned, and the carbon is carried off as soot. When supplied with enough oxygen, it burns with a yellow flame; when supplied with too little, a reddish flame and soot is formed. The conditions of perfect combustion are enough air, sustained high temperature, and thorough mixing of the gases. Trees and shrubs are killed by the sulfurous content of smoke. With hand-firing irregularities are great. Steam-jets are employed; they should be semiautomatic. The best solution of the smoke problem is mechanical handling of coal.

Mechanical stokers may be divided into: Inclined; shaking grates; traveling or chain grates; and underfeed stokers.

Inclined. Single or double inclined stokers need frequent cleaning and with clinker-making coal too much slicing.

Traveling, or chain-grate stokers, are said to be the best form of grate used.

Underfeed stokers are economical and virtually smokeless.

A smoky chimney indicates waste, but a smokeless chimney is not necessarily an indication of economy.

Letters from persons using mechanical stokers favor this system.

Table of efficiency of combustion is included.

A recent improvement that promises well is a combination of steam jets and oil vapor at the bridge wall. Baffle walls have also assisted in maintaining high temperature and mixing the gases.

1905


Construction and operation of equipment between 1840 and 1860. (MIR—Bib.)

1907


Discusses theory and gives results of many tests to determine efficiency with various speeds and gradients. Most efficient combustion takes place when the vacuum is relatively small and the speed high. (MIR—Bib.)


More extended account of experiments on Pennsylvania Railroad in 1859, described in author's previous paper. "The author has at no time found records of experiments ** on any other road so carefully conducted." Tests conducted between Altoona and Gallitzin and Altoona and Mifflin proved that smoke could be greatly reduced, that soft coal was superior to best grades of wood, and that Pittsburgh coal from storage bins was only very slightly inferior to Broad Top coal (mined for the experiments on account of its more rapid deterioration owing to exposure). (MIR—Bib.)


Abstract report to Traveling Engineers' Association. Gives recommendations for improvement of practice. Concludes that mechanical devices of some kind, to assist the fireman, must sooner or later come into use. (MIR—Bib.)


Describes apparatus for application on locomotives. Air is forced in front end of firebox immediately below brick arch. (MIR—Bib.)

1909


Effect of use of brick arches is given particular attention, and tables are given showing comparative tests. (MIR—Bib.)


Comments presenting doubts and objections. (MIR—Bib.)


Emphasizes difficult nature of problem confronting railroads, and outlines attempts at solution by installing automatic devices for firing, supervision and training of firemen, and experiments with electrification. On 19 of the principal roads recent fuel bills exceeded 11.4 percent of total operating expenses, or nearly 8 percent of the gross earnings. Considers possible economy resulting from change in form of fuel or from improved methods of firing. (MIR—Bib.)


Economy of fuel rather than smoke prevention is object. Unskilful stoking and faulty boiler arrangements are discussed. (MIR—Bib.)

Summarizes work of others without presenting original material to any great extent.

Concludes that "elimination of smoke nuisance, so far as the railroads are concerned, is feasible. Primarily it is a matter of proper firing and the use of the right sort of materials." (MIR—Bib.)

1911


Gives results from careful observations, showing density of smoke from railroads. (MIR—Bib.)


In discussing the problems of the corrosion of metals, data are given on the effects of atmosphere on rails in the open and in tunnels. Reference is made to the frequent statement that examination of corroded residues is inconclusive. Although so far as chemical constitution is concerned there may be truth in this, in most instances of exceptional corrosion a detailed examination of the residue will give some clue as to the cause.

The results given represent instances noted over a long period of time and a diversity of geographical position, yet one characteristic feature is maintained throughout, the distinct content of sulfur in the residues. To some extent corroded deposits may be taken as an index of the sulfurous character of the surrounding atmosphere. In no problem of corrosion can local conditions be ignored, and in most instances they are of equal importance to the character of the metal that has been corroded. The importance of external conditions has been verified in many cases, and, although it is impossible to control them, they must still be recognized when attempting to reach the truth of any special problem. In discussions as to the relative corrosion of wrought iron and steel, external conditions have not always received a just measure of recognition.

It is also stated that the problem of corrosion does not lie in the amount of metal lost by rust or decay but on the influence exerted on the metal remaining intact and apparently unaffected. Deterioration is found that is not explained by mere loss in weight or by change in the ordinary composition of the metal.

1912


Condensed from report of chief engineer of the Chicago Association of Commerce, Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals (MIR—Bib.)


Careful firing is mentioned as the most important field for improvement. Records of locomotive equipment and of inspection are given. (MIR—Bib.)


Illustrates and describes equipment considered necessary to prevent emission of dense smoke from locomotives. Discusses briefly the "Security" brick arch, claiming advantages over former types, and especially recommends steam-induced air jets. (MIR—Bib.)


Paper before International Association for the Prevention of Smoke, at Indianapolis, Ind., Sept. 25, 1912. (MIR—Bib.)


Condensed from Bulletin 6 of Chicago Chamber of Commerce's Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals. Tests were made with Pocahontas and Illinois coal, and analyses were made of ash and flue gases. (MIR—Bib.)


Based on records compiled by engineers of the Chicago Association of Commerce, Committee on Smoke Abatement and Electrification. (MIR—Bib.)

1913


Engines were being given a heavy overload, which made proper firing impossible. Also the engines were not properly equipped in the way of extra steam jets, fires, arches, stack blowers, etc.

The owners purchased recommended fuel 1 month and then changed to another fuel the next month so that whereas the smoke nuisance has been temporarily eliminated at the plant, the relief has not been permanent.

1916


Owing to conditions peculiar to St. Louis, total elimination of smoke from locomotive boilers is impossible, nonvolatile coals are not readily available, and economic reasons restrict fuel to bituminous coal from the vast Illinois coal fields.

To combat the smoke evil the railroad company at great expense equipped its locomotives with a smoke-elimination device. However, like similar devices, it is operated by the steam of the locomotive and cannot be used until steam is generated in the boiler.

Methods of firing to prevent smoke are described.


A practical view of the steam jet form of smoke is discussed. The beneficial results obtained in Chicago in abating smoke nuisance, because of the close supervision exercised by the Railroad Smoke Inspectors' Association acting in cooperation with the City Smoke Department, are clearly illustrated in 13 figures.


Discusses briefly the accomplishments of the Pennsylvania Railroad in Pittsburgh in its efforts to solve the smoke problem.

1921


Summary is presented on the following essentials of eliminating the smoke nuisance on railroads. (1) Prepare the locomotive; (2) prepare the fuel; (3) prepare the men to operate the locomotive successfully, judiciously, and economically.
1923
Carbon monoxide is the offending gas; temperatures and humidity are increased, and asphyxiation is possible in passing through tunnels. Descriptive data on the tunnels is given. Recommendations include use of smoke deflectors, breathing air from the train's air lines, wearing of gas masks, and reduction of time spent in the tunnels by increasing speed. (USPHS)

1925
Discusses advantages gained through eliminating smoke by the fireless steamng system. Attention is called to the fuel economy resulting from using this system.
The following manifestations of smoke are discussed: (1) Cloud effect; (2) dust and dirt.
The procedure used by the city Smoke Abatement Board when a violation is reported is outlined.

1926
The smoke problem is a question of perfect combustion. The factors are outlined that enter into the operation of a steam engine and bear on combustion.

1927
The various sources of smoke in large towns are reviewed. Reference is made to the smoke from railway locomotives and the possibility of the Chamber requiring the replacement of steam locomotives by electric traction in the vicinity of great towns. This is regarded as impracticable for the moment, but reference is made to the possibility of controlling the emission of smoke from railroad locomotives and steamships and from large shops, hospitals, hotels, and other places with central heating in the same manner used with factory smoke. Emphasis is laid on the importance of the full utilization of the products of distillation of coal, part of which at present escapes into the air and creates a public nuisance, and the national importance of restricting the importation of raw materials such as heavy oil and petrol. An interministerial commission is engaged in the problem of carbonization of pit coal. (BH)

1929
Discussion on the railroads' contributions to the work of smoke abatement and the extent to which locomotives have improved.
It is claimed that the oil-electric locomotive has a high first cost, when compared with steam locomotives, but justification for use of the oil engine lies in eliminating smoke and reducing total operating cost, which are sufficient to show an added return on the added investment.

It is safe to say that on account of high thermal and mechanical efficiency and a minimum quantity of smoke emitted, the oil-electric locomotive is destined to replace the steam locomotive within our city limits more and more.
Methods are described that have been employed in an effort to eliminate the smoke nuisance at roundhouses. Enumerates advantages derived from direct steaming.
Methods for preventing smoke on railroads are discussed.

1930
Figures presented demonstrate in a striking manner the results obtained in smoke elimination at a certain terminal by using Pocahontas coal.
During the 29 months of smoke observations of locomotive performance there was no violation chargeable to Pocahontas coal.
Even in using low-volatile coal some smoke can be made unless locomotives are fired more often.
Presents analysis of the medium- and low-volatile coal used on passenger, freight, and yard locomotives.
Two recommendations for smoke abatement are presented:
1. To the public: See that your town, city, or county attacks smoke abatement as a permanent nonpolitical engineering job and lets the best possible engineers to take charge of it.
2. To the railroads: For your own benefit and the public benefit, pool your interests in smoke abatement and establish a central agency to work out, test, standardize, and put into effect designs, devices, and methods for smoke abatement.
The major developments that are under way tending toward improvement in smoke abatement are: (1) Purchase of electric current where this can be obtained more economically from a large central power-generating station; (2) construction of a single large power plant with distribution lines to the points previously served by the several small plants; (3) use of pulverized coal; (4) direct steaming; (5) purchase of steam direct from large central boiler plants.

1937
The obnoxious fumes, due to aldehydes in diesel exhaust gases, can be washed out with a Hunslet conditioner, which can be attached to a diesel engine. This conditioner, using a water washer, also eliminates hot carbon sparks that might be a fire hazard. The important thing in a conditioner is to conserve the water supply as far as possible and, should the water supply run low, still insure against fire danger. The Hunslet conditioner is designed to achieve this ideal.
A sketch of the Hunslet conditioner, which shows its construction and describes its operation, is included.
Although the exhaust gases, during their course through the conditioner, pass through materials that ensure a thorough scrubbing action and the removal of the alkaloids, what these materials are is not specified. The described system has been applied to all sizes of diesels. (CLAC/UCLA)

In abating railroad smoke the problem has been attacked on two angles—improving the fuel-burning equipment and educating and supervising the men firing the engines. These two angles are discussed, and the results accomplished are mentioned briefly.

Although it is true that 75 to 90 percent of the locomotive coal is burned while the engine crews are in charge of the locomotives, 100 percent of the coal is burned in the locomotives themselves. A careful, conscientious engine crew, by exerting a high degree of skill, can perform wonders with a machine in poor operative condition but will do still better if not so handicapped and do it with less conscious effort—more automatically and more consistently. The most important point of smoke abatement the important features of locomotive maintenance are outlined by the author. Rules for the firemen are included also.

1938

The brick arch is discussed as an important factor in efficient heating. Its function in a locomotive is to prevent the flames from coming into contact with the colder surfaces of the flue sheet and fluxes until combustion is virtually completed. That is why a locomotive with a brick arch is more nearly smokeless than one without such an arch.

The factors that enter into selecting a fuel for use on the railroads are the type of coal that gives the best performance even at greater cost per ton at the mine; the preparation and size of the coal; and the question of smoke. With regard to the last-mentioned factor, low-volatile coal is usually used in cities and high volatile in the open country. Even with low-volatile coal it is possible to make smoke, and constant vigilance is required on the part of the engine crew to prevent smoke violations.

Locomotives have been equipped with all the devices known to science to assist in improving combustion and to make the work easier for the employees. A few of these devices are the locomotive stoker, improved grate, grate shakers, improved front end arrangement, automatic fire doors, brick arches, and smoke consumers. The engine crews are given every opportunity, from an educational standpoint, to become proficient in the art of operating and firing a steam locomotive.

Much detailed information is given regarding the proper firing of locomotives using coal or oil as fuel.

Reports on tests conducted by the Worcester Street Railway to determine how many coaches were gassing and to investigate ways of eliminating this trouble. Tests were made upon a number of coaches using more volatile fuels by trying high-temperature manifolds and installing degassing valves. It was found that a highly volatile fuel will eliminate smoke and greatly reduce odor in the exhaust from any gasoline-powered engine providing it has a reasonable oil consumption. Increasing manifold temperatures did not seem materially to eliminate gassing and the result of this temperature increase was a very definite power loss owing to loss in volumetric efficiency. Several types of degassing valves were tried with very little or no success, and even if the unit functioned properly on one operation it had no effect on fumes owing to acceleration. It was therefore concluded that the best way to eliminate fumes was to use a high-volatility 50-octane fuel. (CLAC/UCLA)

1939

Discusses calculation and subsequent adjustment of air-fuel ratios in gasoline and diesel engines through the analysis of their exhaust gases. A common type of Orsat analysis is used but differs from some others in that calculations are based on the oxygen content of the exhaust gases rather than on the more common CO₂ standard. The slope of the oxygen curve is 1.4 times greater for all values of excess oxygen furnished for combustion than is the CO₂ curve. Employment of the oxygen value is justified by the apparent greater permissible error in determining the O₂ content of the exhaust gas. (CLAC/UCLA)

Various steps taken by the railroads toward smoke elimination, such as introducing the brick arch and the combustion chamber, educating firemen and, most important, preparing locomotive coal properly, are outlined. As to the future, replacing of steam locomotives by diesels is seen as going a long way toward solving the problem of objectionable smoke.

A series of tests was run on a 4-cylinder diesel engine of 50 b. h. p. at 1,250 r. p. m. directly connected to a cradle-type electric dynamometer. Smoke in an engine exhaust indicates incomplete combustion and poor efficiency. Engine performance predictions by exhaust smoke analysis must be considered as a compromise of known performance characteristics.

The fuel ignition delay period is very significant in determining the combustion quality of the fuel and an optimum injection point quality exists, and thus, minimum exhaust smoke density. Governor settings are also very important, since it was found that under adverse conditions of rich air-fuel mixtures and high intake quality there was an increase in exhaust smoke.
The investigations showed density decreases with increased air intake vacuum until a critical point is reached, at which brake horsepower and smoke density increase rapidly. This is due to the excess of fuel and the rapidly increasing ignition lag.
The data presented are the results of test-stand experiments that do not, therefore, completely cover actual operating conditions. It is concluded, however, that the ignition quality of the fuel is of primary importance: exhaust smoke varies with the timing of diesel fuel injection, with engine load, and with air intake vacuum. It is indicated that further study of exhaust smoke should be of great help to diesel-engine manufacturers and test engineers. (CLAC/UCLA)

Discussion of methods of smoke abatement used by the Hudson County, N. J., Railroad Smoke Association. Meetings are held at which railroad problems are discussed. The subjects are not necessarily restricted to smoke abatement or to railroad employees; however, discussions are usually devoted to smoke abatement.

Since the organization was formed 8 years ago there has been an improvement of 92.4 percent in smoke prevention.


Describes firing practice on locomotives of the New York Central Railroad. This railroad has recognized its responsibility in being a good neighbor and not wanting to offend by producing unnecessary smoke and has, therefore, equipped its engines with every known device to control smoke. Some of these devices are described.

1940


These reports and the investigations upon which they are based are in regard to the factors that must be considered if diesel engines are to be used safely underground. Two four-stroke-cycle diesel engines, one of maximum rated speed of 1,400 r. p. m. and 44 b. h. p. and the other of 2,600 r. p. m. and 7 b. h. p., were used in the experiments. Both were in good mechanical condition and each was mounted on a power unit. Exhaust-gas samples were taken and required analyses run to determine the factors of interest to the investigators.

Exhaust-gas analysis was made for carbon dioxide, carbon monoxide, oxygen, hydrogen, and methane; these data then were correlated with fuel-air ratio. It was shown that the concentration of these constituents is governed by the fuel-air ratio and varies as the relation of fuel to intake air.

As aldehydes emitted in the exhaust gas have an offensive odor and cause irritation, they too were determined. Concentrations of aldehydes ranged from 0 to 6 p. p. m. in the exhaust from one engine and from 0 to 31 p. p. m. in that from the other. There was a definite increase in the concentration of aldehydes at the low fuel-air ratios. The presence of aldehyde indicated a chilling of the products of the oxidation portion of the combustion process in the diesel engine. Evidence was obtained supporting the theory that direct oxidation and destructive combustion were taking place simultaneously.


The railroads have met the challenge of the smoke prevention problem in a fine manner. The problem can be solved by intelligent, systematic, and persistent supervision and with regular equipment and fuels. Future possibilities are discussed.


The items that should be given careful consideration in eliminating locomotive smoke are presented and reviewed as follows: (1) Supervision; strict and constant supervision is most important in eliminating smoke from locomotives. (2) The human element; although it is impossible to make the human machine 100 percent efficient, we should strive to make it approach that goal. (3) Improved firing methods. (4) Maintenance of equipment. (5) Drafting of locomotive. (6) Selection of fuel. (7) Aids to combustion. (8) Smoke consciousness.

Presents outline used for panel discussion on railroad locomotive smoke abatement. This outline is based on the eight points mentioned.


Discussion is confined to eliminating smoke from locomotives. The following factors are presented and explained: Arches, combustion, grates, fuel, locomotive preparation, exhaust nozzles, firing practice, design, and education.

When the designer has given due consideration to operating characteristics, the engineer and the fireman, by care and diligence, should undoubtedly be able to aid very materially in conforming with smoke abatement regulations and, although the fuel may be coal or oil, the steam locomotive will probably be with us for some time to come, rendering a very useful service.


Experiments were run on a 3½- by 4½-inch 4-stroke C. F. R. diesel engine. It was found that by increasing the oxygen concentration from the normal 21 percent to 45 percent the indicated horsepower increased from 4.3 to 6 and the brake horsepower from 2.9 to 4.65. With 55 percent oxygen concentration the power figures were increased somewhat, but above 50 percent oxygen detonation was experienced. It was also found that raising the oxygen concentration to 45 percent is equivalent to raising the ignition quality of the fuel by 10 cetane numbers and a raise to 26 percent oxygen increased the apparent cetane number in a running engine by 10. Among other important observations was that a 5-percent increase in oxygen concentration is enough to make a black exhaust invisible. The investigations indicate that a considerable saving can be made in engine weight in that through oxygen boosting the weight per take-off horsepower can thereby be reduced from 2 to 1.54 pounds. (CLAC/UCLA)


Railroads have made tremendous improvement during the past 15 years in smoke abatement and fuel conservation.

Aside from the economic and health aspect, railroads have another very good reason for constantly campaigning for smoke reduction, and that is, making passenger services more attractive (not having the view obstructed by trailing smoke).

The following points are discussed: Locomotive design, automatic draft control, and everyday educational work in art of firing.

1941


Discussion of the battle against smoke in Chicago, the largest railroad center in the world considered from either the volume of tonnage handled or the extent of facilities. The railroad-smoke problem in Chicago can be classified into two major divisions—the locomotive terminal problem and the locomotive-in-service problem.
Measures for solving these problems are described with figures and a table giving the details of the progress attained in smoke prevention, with the active support of the railroads.


Knowledge on existing conditions with regard to the railroad-smoke problem, which threatens to become a continuous proposition, is stated plainly.

The efficient everyday operation affected by the introduction of the front delivery stoker is described. Some of the reasons are given why the economies are so pronounced with this type of coal firing. The exercise of eternal vigilance and everlasting work are necessary to eliminate successfully the objectionable smoke.


The significance of data on the combustion processes in the diesel engine is discussed. Two diesel engines in good mechanical condition were tested; exhaust-gas samples were taken and analyzed for oxygen, carbon monoxide, hydrogen, methane, nitrogen, aldehydes, and oxides of nitrogen.

Among the topics discussed are: The relation of exhaust-gas composition to fuel-air ratio; the relation of exhaust-gas composition to combustion performance; the products of incomplete combustion and the significance of these factors in the light of safe diesel operation.

The products of incomplete combustion in diesel engines are carbon monoxide, aldehydes, free carbon, hydrogen, and methane. Two processes of combustion occur simultaneously. These are direct oxidation and destructive combustion. If the reactions in the direct-oxidation process are chilled before oxidation is complete, carbon monoxide, aldehydes, and organic acids will be present in the exhaust gases. Increase in concentration of CO and aldehydes at low fuel-air ratios indicates that chilling is more pronounced at these ratios.

Aldehydes, in addition to being significant in relation to combustion, also are of interest in relation to the acid exhausts from diesel engines. The odor and irritation of aldehydes can be detected at extremely low concentrations and a correlation has been observed between aldehyde concentration and these physiological properties.

The significance of oxides of nitrogen and oxides of sulfur in relation to the operation of internal combustion engines are discussed briefly. (CLAC/UCLA)


The tuyère-type grate is described. It should insure or make possible a level uniform fire over the run, letting the fireman control his smoke at the intermediate stops and with an ash accumulation give a uniform fire bed for the terminal movement to the clinker pit.


The cyclone front-end and the Anderson front-end methods developed to prevent the escape of live sparks from the locomotive stacks that might set fires along the right-of-way are discussed. These front ends are efficient spark arrestors but have been so improved that they are also first-class draft appliances. Changes in the Anderson type have also greatly facilitated installation of the front end and other maintenance work in the smokebox. They can be applied to suit virtually all track sizes.


Exhaust-gas composition from two diesel engines in good mechanical condition was determined at various speeds and power output. The exhaust-gas constituents were CO, NO oxides, CO₂, aldehydes, soot, O₂, N₂, H₂O vapors, and in some instances H₂ and CH₄ or other hydrocarbons. Carbon monoxide, carbon dioxide, and oxides of nitrogen were found in quantities harmful to breathe, and, in many instances, very objectionable amounts of aldehydes and smoke were produced.

The well-known, characteristic pungent odor of diesel exhaust is laid to aldehydes, which are products of thermal decomposition due to incomplete combustion of the diesel fuel. In the described tests the concentration of aldehydes in the exhaust gases ranged from 0.5 to 2.5 percent. A comprehensive program of correlation of odor and irritant intensity in relation to aldehyde content was carried out. These tests tend to relate very closely a definite increase in odor and irritation with increase in aldehyde content. Although aldehydes, in the concentrations found, do not appear to be definite health hazards, they constitute a significant nuisance worthy of considerably more study.

A study of aldehyde content and fuel-air ratios indicated a definite increase in aldehyde formation at the low fuel-air ratios. It also was found that aldehyde concentration in the exhaust gases tended to decrease with increase in speed, and it appears that engine design and operating conditions have a marked effect on aldehyde production.

The production of carbon monoxide and smoke, as well as aldehydes, can be largely controlled by the proper adjustment of fuel-air ratio without a significant loss of power output. (CLAC/UCLA)


In diesel-engine operations when the exhaust gases contain carbon monoxide in the amount of 0.01 percent and carbon dioxide less than 1 percent, ventilation in a tunnel in which the diesel is used is poor and the aldehydes and other irritants are obnoxious after a relatively short exposure. In general, the irritants, such as aldehydes, odors, and smoke follow the trend of the toxic gases, but under improper maintenance they are conspicuously present at all stages of operation. Proper mechanical condition at all times is necessary for a diesel engine to insure against its exhaust containing dangerous concentrations of noxious gases.

The aldehydes and other organic compounds are very irritating to the eyes, nose, and throat. As measurement of the quantity of nitrogen oxides, aldehydes, and carbon dioxide and control of smoke in the air constitute a slow and difficult procedure and measurement of carbon monoxide is relatively simple, precise measurements of the latter are used effectively to evaluate the quantity of toxic fumes, gases, odors, and irritants.

The investigation shows the value of field study of diesel locomotives in actual operation, and it was observations so obtained that indicated the amount of carbon monoxide in the exhaust gas as a yardstick for the control of atmospheric conditions. The control of noxious gases in the general air when diesel locomotives are being used should be based upon a carbon monoxide control value of 10 to 20 p. m. (CLAC/UCLA)
AIR POLLUTION—A BIBLIOGRAPHY


Exhaust gases will contain no visible smoke or offensive products, provided the engine is maintained in good mechanical condition, correct fuel is used, and the operator knows how to handle his engine correctly. Correct combustion requires: (1) Correct proportion of fuel to air; (2) correct temperature; and (3) correct mixture of fuel and air. Neglect of any one of the three causes poor combustion and likelihood of smoke.

Causes of visible smoke in exhaust of diesel engines are: (1) Improper proportions of air and fuel; (a) deficiency of air; (b) excess of fuel; (c) presence of lubricating oil above piston; (2) Lack of temperature; (a) loss of compression; (b) excessive cooling; (3) Improper mixture of ignition of air and fuel. Locomotive diesels offer no problem; expert maintenance and operation have eliminated smoky exhaust. CO in diesel exhausts is very low, 0.1 percent and under. It is pretty well established that offensive exhaust gases from diesels are the aldehydes of the type resulting from incomplete combustion of the fuel. Concentrations as low as 10 p. m. have very acid odor and concentrations of 50 parts per million cause perceptible irritation.

It is believed that the cure for these aldehydes-containing exhaust gases lies in proper engine design and selection of proper fuel. Active work is being carried on by subcommittee on odor and lachrymation of Cooperative Fuel Research Committee of the diesel industry. (CLAC/UCLA)


A simply constructed fume trap is described that will eliminate the fumes from the engine rooms in which stationary diesel engines are housed. The arrangement consists of merely connecting the air intake manifold and the breather pipe with a ½-inch pipe containing a gate valve. The gate valve is so regulated that when the engine is at full throttle and the breather pipe with the intake manifold just overcomes the back-pressure in the crankcase. It is claimed that with this connection, smoke is not only freed from the discomforting fumes but is also actually burning and obtaining power from them. (CLAC/UCLA)


An extensive laboratory investigation was carried out in two popular automotive-type diesel engines to determine the influence of individual fuel properties on engine performance as reflected by smoke and odor, power, and economy. It was observed that, as engine output is decreased from high load conditions, exhaust smoke decreases until a point is reached where there is a sudden increase in smoke. Further decrease in fuel rate results in an increase in smoke until a maximum is reached after which smoke decreases when combustion ceases. Smoke occurring at fuel rates above that for minimum smoke was of the black type, whereas that occurring below this value was white. Increase in cetane number will produce a decided decrease in exhaust smoke because it can support combustion under adverse conditions of low output.

The pungent odor of diesel exhaust gas is related to its aldehyde content in terms of formaldehyde. Analysis showed that the coefficient of deceleration the exhaust always contains aldehydes in appreciable quantity. Chemical analysis showed that formaldehyde was present in every sample examined; acetaldehyde rarely; acrolein was never found; and other aldehydes were either absent or the tests obtained were so questionable as to be of no value. As engine output decreases from high load conditions, exhaust odor decreases until a point is reached where there is a substantial increase in odor. Further decrease in fuel rate results in increase in odor until a maximum is reached at the lean limit of combustion. Low output conditions favoring smoke also favor formation of the most objectionable odors, and maximum aldehydes occur just before the lean limit of combustion is reached.

It is indicated that exhaust-gas odor depends only upon completeness of combustion in the cylinder and is independent of liquid fuel in the exhaust system.

Both cetane number and volatility influence exhaust smoke at idling; an increase in either improves performance in this respect. Cetane number, however, was the only fuel property found to influence exhaust odor; an increase in cetane improves performance.

It is not possible to obtain all of the desirable results with a single fuel. At present the solution seems to be a fuel selection on the basis of a compromise among the various factors involved. Proper interpretation of engine performance overdrive is desired and consideration of the type and mechanical condition of the engine used should result in the selection of fuels for utmost satisfaction. (CLAC/UCLA) 1943


Discussion of the relationship of wide-open throttle and short valve travel cutoff versus lighter throttle and longer valve travel cutoff in locomotive operation to fuel economy and smoke abatement.


Discussion of the Pittsburgh locomotive smoke-control ordinance and the measures taken by the railroads to comply therewith. 1944


Reference is made to perplexities due to abnormal war conditions connected with operating the railroads that make smoke abatement increasingly difficult. Moreover, any progressive and wide-awake railroad management realizes for civic and economic reasons that the days are past when an abundance of black smoke can escape from locomotive stacks, power-house chimneys, or roundhouse smoke jacks. Proper supervisory and educational efforts to eliminate unnecessary smoke should be a part of modern railroad operation.


Discussion of efficiency of steam air jets under different operating conditions. "The chief advantage of the steam-air jet is of great help in reducing smoke in stationary plants where there is large combustion space and light draft. If the combustion space is small or the draft heavy they are ineffective." Experienced firemen and engineers would agree to stop smoke on any properly equipped locomotive by manipulating the door openings and the results would be as satisfactory as those obtained with steam jets. So successful has been the method of filling smoke by admitting air through the fire door that it has been adopted and taught to locomotive crews.

The use of direct steaming of locomotives for smoke abatement is said to have given satisfactory results in Chicago, Cincinnati, and other cities.

Other means that will abate smoke from locomotives at terminals are available, but they are more costly to maintain and have no compensating economies or operating advantages such as are derived from floating or resteaming locomotives with steam supplied by efficient stationary boilers. Gives details of operating this method of locomotive smoke abatement.


Smoke abatement is a very serious problem confronting the bituminous coal-burning industries. Discusses results of experiments on a locomotive with application of overfire air with a steam-jet air device. This device, when properly designed and applied, provides the fireman with reasonable care in managing the fire, with a means of controlling smoke.


Methods used on the New Haven Railroad to eliminate smoke are discussed briefly. It is believed that the minimizing of smoke is not a one-man job; it needs strict and constant supervision and must be in the mind and will of the men responsible for design, maintenance, handling, and operation of locomotives. These men should be thoroughly sold on the idea that smoke prevention is possible and highly desirable.


The contributing factors responsible for emitting smoke from the stack of locomotives are design and maintenance of equipment, quality and preparation of fuel, and the human factor. These various factors are discussed in detail.

1945


Considers human element involved in burning coal on locomotives. Black smoke emitted from the stacks of locomotives indicates carelessness either on the part of one or both members of the crew: improper design of locomotive grates, ash pan, or draft arrangements; or improper maintenance of the locomotive. Discusses laws governing combustion and some of the appliances that have been installed on locomotives to insure as nearly complete combustion as possible.


Outlines firing practice to eliminate black smoke from locomotives. (FA)


The “iron horse” has not advanced with combustion technology. It still emits black smoke and wastes as much as 30 percent of its fuel. Research on air supply to the locomotive firebox is discussed. The viewpoint that oxygen burns and that the unburning substance supports combustion is just as logical as to say that coal "burns" and oxygen "supports" combustion. Thirteen pounds of air has to be supplied to the grate of the locomotive for each single pound of coal. Tests made confirm the importance of air as the primary fuel for combustion.

In addition to the substantial saving in fuel cost, reduction in locomotive maintenance, and increase in power, the proper application of air as a fuel to the railroad industry will eliminate smoke in road service.


A study is described in detail, with illustrations, of ring-blower designs in steam locomotives made in the interest of smoke abatement and conservation of fuel, by the Illinois Central Railroad in conjunction with the Smoke Abatement Department of the city of Chicago.

It is stated that tests of this sort give very good returns on the investment made.


Discusses fundamentals in preventing smoke in coal-burning locomotives. These fundamentals must be recognized insofar as is physically possible. The men who operate locomotives should fully understand the problem and be properly instructed. The locomotive and its firing equipment should be so designed and operated that man failure is reduced to the minimum. The future of smoke prevention in operating coal-fired locomotives will depend a lot on the application of mechanical fuel-burning equipment designed to give maximum combustion performance under all conditions of service and operated by men who fully understand their work.


The force required to propel the three principal types of vehicles—the locomotive, the automobile, and the airplane—is analyzed. The locomotive is the only device capable of pulling large loads at high speeds over long distances.

The fire-tube boiler has just about reached its limit in steam pressure and temperature; and, unless boiler efficiency can be improved, it seems evident that larger locomotives must await the development of a new kind of prime mover. The combustion-gas turbine, because of its relative small size, light weight, and reasonably good thermal efficiency, seems to be very well adapted to locomotive service. This type of prime mover is described and illustrated. When the problems involved in burning coal can be solved, it is expected that the coal-burning, gas-turbine locomotive will again make coal the foremost fuel on the rails. There should be no question of smoke because of the tremendous amount of excess air that is available to guarantee complete combustion of the fuel.

1946


The tunnel is 7.79 miles long and 314 square feet in cross section. The observed concentrations of carbon dioxide were not considered hazardous, nor was the oxygen content of the tunnel air depleted to a significant degree by the exhaust gases of the diesel. The maximum observed concentration of carbon monoxide was only slightly above 0.01 percent, the maximum generally considered permissible in the air of working places. Oxides of nitrogen were found in a considerable area behind the train. In concentrations exceeding the concentration of 25 parts per million considered
the maximum permissible in the air of working places and under conditions of minimum air movement in the tunnel must not expose persons not work in the tunnel. Data on physiological response to various concentrations of oxides of nitrogen are cited. Under typical operating conditions the diesel locomotive was found to leave behind in the tunnel a wake of smoke and gases some 20,000 feet in length. Passage of trains through the tunnel created air movement in the same direction as train movement, the air velocities thus created being somewhat less than train speed. Under typical operating conditions in the Cascade tunnel approximately 20 percent of the air in the tunnel was forced out of the tunnel ahead of the train, and 50 percent of the air slipped back past the train through the clearance space between train and tunnel walls. An electric train following a train with the diesel locomotive would aid materially in clearing the tunnel of smoke and gases left by the diesel. Trains passing through the tunnel in the direction opposite to that of the diesel probably would act to keep smoke and gases in the tunnel. A diesel locomotive stopped in the tunnel with engines operating might create hazardous conditions in the vicinity of the locomotive. (FA)


The economics of automatic control is discussed, and the principle and operation of the controls are explained in detail, first for hand-fired locomotives and then for stoker-fired locomotives. (APB)


The burning of coal on locomotives, the laws governing combustion, and some of the appliances installed on locomotives for more complete combustion are considered. (FA)


Of the various constituents of diesel exhausts, all are colorless and odorless except the products of incomplete combustion. But one of these, visible smoke, is discussed. One of the reasons for smoke is the design of the diesel engine, and it is an obligation of the manufacturer not to allow his engines to emit exhaust gases of an objectionable nature. It has been found that when too much fuel is fed to the diesel engine, the exhaust gases will contain large quantities of carbon monoxide, unburned fuel, aldehydes, and unburned carbon particles. The smoke content is evaluated. This is accompanied with a fully described photoelectric smoke meter. The test procedure, incorporating this smoke meter, is described, a means of interpreting results is given with appropriate equations and a few graphs of results of actual tests. (CLAC/UCLA)


Investigations were made with regard to diesel fuels within distillation ranges of 400° to 500° F, 500° to 600° F, and 600° to 700° F, and having cetane numbers of 40, 55, 70, and 90. Among tests made were those concerned with flame initiation and duration, ignition delay, rate of pressure rise, peak cylinder pressure, flame intensity, flame temperature, and smoke emission. In conducting the smoke measurements a tube-shaped photoelectric cell-type of smoke meter was used. Smoke from low-distillation-range fuels was black, whereas that from high-distillation-range fuels had a bluish cast. In general, the low-distillation-range fuels of the higher cetane numbers produced the least smoke.

Paraffinic fuels in the higher boiling range, however, crack and oxidize more readily and are thus more completely burned. Diluting and high-boiling fuel with a low-boiling cetane improver produced less smoke, whereas there was a definite increase in smoke with lighter fuels when an improver was added.

Several causes of smoke emission are discussed, and it was noted that a high concentration of fuel relative to oxygen content caused dense smoke. Additional experiments along the line of fuels, cetane improvers, and blends would lead toward much needed information with regard to diesel exhaust smoke. (CLAC/FA)


The Sweeney overdoor smoke jet is described and illustrated. (APB)


The importance is stressed of the human element in smoke prevention—its training, coaching, and control—and the rapid progress made in this direction in recent years by concentrating on training the supervisory staff and employees in the proper handling and use of fuel. In the field of technical research, one phase that has dealt more specifically and quite effectively with locomotive smoke prevention is the use of the overfire steam-air jets. (APB)


Report of a conference on smoke abatement and conservation of fuels that points out that railroads are not the worst offenders as far as the pollution of the atmosphere by smoke is concerned, and actual figures support this statement. As smoke and soot are evidences of poor combustion and wastefulness, a smoke preventive program was drawn up with successful results. The importance of training the men on the locomotives, the designers, and the repairers to be smoke conscious is underlined. Describes a device that helps to prevent smoke and improve combustion efficiency by introducing supplementary air. It consists of overfire air jets situated on each side of the firebox in steam locomotives, or automatic smoke control for hand-fired locomotives and supply of air to coal-fired locomotives using the “front-end” system of exhausting the steam from the cylinders into the stack through a fixed nozzle also are considered. (FA)
about 2,000 locomotives with jets patterned either after the designs discussed or after modifications of them. The fundamental of steam-air-jet design and features important for optimum performance are given. Two types of jet, for use with locomotives having fireboxes less than 96 inches in width and 96 inches or over, respectively, are described and illustrated. It is recommended that high-carbon-steel nozzles and features be used and, to avoid clogging, it is advisable to blow down all piping to the jets with steam at not less than 100 p. s. i. while tapping vigorously with a hammer. General recommendations for locating, spacing and sizing the two types of jet on switching and on hand-fired and stoker-fired road locomotives are made and formulas are given for calculating the maximum continuous air-rate of the locomotive and the minimum overfire-air capacity per jet. Control systems are described and the advantages, disadvantages, and method of application of turboblower jets are considered. (APB)


Recently, investigations of the steam-air jet have been conducted by Bituminous Coal Research, Inc., which has developed optimum design values for such devices. Gives results of tests and details of application of steam-air jets. Discusses the history and development of railroad overfire jets; desirability of overfire air; muffler design, location, spacing, and capacity of jets; hand and stoker firing; need for automatic controls; and alternative types of jets, for example, exhaust steam, turboblower, and counterflow jets. (APB)


Reports of organization show that 32 railroads have 1,840 locomotives utilizing overfire steam-air jets to control smoke. Includes list of railroads together with the types of jet-equipped engines on each. (FA)


Describes methods used since January 1946 by the St. Louis Division of Smoke Regulation to reduce the railroad-smoke nuisance. The companies operating in that city have assigned men as smoke inspectors who work with the city's inspectors, and monthly awards of ribbons are made to both roundhouse and engine engineers for the best performance. Table showing observations and violations of the ordinance, compiled by the inspectors for the years 1943 to 1947, show clearly the value of the methods. (APB)


It is doubted whether a great deal of benefit is derived from the overfired jet on locomotives in through road service, but the jets perform satisfactorily on yard switching locomotives owing to the fact that the greater portion of the firing on these engines is done when the engine is standing. Engines can be fired with very little, if any, smoke, if they have the proper air opening in the grates, proper ash pan opening, a firebox clear of leaks, and clean flues. (APB)


Reference is made to the various factors that enter into the successful use of overfire jet-induction tubes as an aid in eliminating objectionable smoke on railroad locomotives, the most important being that the locomotives should be in good condition, that is, no air leaks in smokebox, the smokebox netting should be clean, the engine should be properly draughted, the grates should have proper openings for the grade of coal to be fired, and arches should be in good condition and tight against flue sheets. Proper ash-pan opening is also essential. The factors affecting installation of the air jets, including the relation between the grate area and the number of jets required and between the height of the grate and the grate level and the condition of the coal to be fired, are considered. In addition to making the operation of the jets automatic with the engine blower, it is advisable to have the jets available through the use of a manual valve so that they may be used manually when it is not necessary to use the blower forcibly enough to cause the trip valve to work. This can be done by locating a globe valve in a steam pipe that bypasses a valve and is placed within easy reach of the fireman. (APB)


The speaker stressed the importance of educating both supervisors and engine crews in the art of coal-firing locomotives so as to reduce the least possible amount of smoke. He described tests conducted by the Pennsylvania Railroad, which has 114 engines equipped with steam jets over the fire doors, to discover which smoke-eliminating device was the most efficient: Induction fans, jets and engines; or the steam jet. The latter was found to be the most efficient. A detailed description of its construction is given. (APB)


The 808 coal-burning locomotives are equipped with overfire jets through the combustion tubes; the oil-burning locomotives of certain classes are fitted with the Dutch-oil firebox arrangement. When crews are placed on engines they are held responsible for the abatement of smoke and a card index is kept of each man observed creating smoke. Disciplinary action is taken if full cooperation in the smoke-abatement program is not obtained. (APB)


Coal-burning steam locomotives constitute one of the most serious single health menace in urban air pollution. They discharge into the atmosphere (1) carbon particles containing carbon monoxide, (2) nitrogen oxides which are irritating to the respiratory tract; (3) noxious gases, which contain sulfur dioxide is the worst; and (4) exhaust steam, which in cold weather remains as a steam cloud. These locomotives are significant contributors to the 500- to 500-foot smogs. One-fourth of the total atmospheric pollution in the Chicago area is from locomotives, and it is suggested that diesel engines may help to solve this problem. Deaths from pneumonia, tuberculosis, and respiratory cancer are higher in smog areas. (USPHS)


Factors are analyzed that involve reducing smoke emitted by locomotives and the design, installation, and operation of various aids to combustion, such as the overfire induction tube, are described. Locomotive firing conditions and the role of personnel are discussed. (FA)


The speaker summarized the educational activities directed toward the elimination of smoke nuisance by
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the Washington Terminal Co. and displayed some of its cartoon posters. He suggested that classes should be held in every enginehouse, with lantern slides showing locomotives and enginehouse jacks emitting dense volumes of smoke indicating poor combustion, followed with proper instructions for avoidance of this condition. Two engineers on full time have been allotted to see that all men responsible for handling fires on locomotives and stationary boilers comply with the smoke-nuisance law, and all steam engines used by roads coming into Washington have some sort of smoke-elimination device. (APB) 1948

The yearly report included results obtained where complaints had been made and investigated to decrease production of smoke by railroads, diesel engines, and dumps. The work done by the chemical and mechanical engineering sections, and the meteorological and research sections is described. (FA)

Describes use of overfire steam jets. (APB)

A method is developed for the rapid calculation of turbine control systems employing two stages of amplification. A number of control systems are described, together with variations. (FA)

Gives advice on the various ways of either avoiding or eliminating exhaust smoke, and evidence is presented to show the increase in exhaust smoke caused by: Exceeding full load; idling with a cold combustion chamber; too early and too late ignition timing; too high and too low compression ratio; poor fuel dispersion; low fuel volatility; and a very high or very low cetane number. The photoelectric smokemeter developed by the author and adopted by C. R. C. and possibly causes for apparently faulty indications, compared with visual observation, are explained. (APB)

Abatement of smoke in the enginehouse territory is the duty of all. It requires strict and constant supervision and must originate in the mind and be the will of the men responsible for the design, maintenance, handling, and operation of steam locomotives. Reference is made to the smoke-prevention laws that prevail in virtually every large industrial center and State, and the railroads are exposed to the penalties enacted in their respective communities for violation of the prevailing law. The statement is made that education precedes, and must necessarily accompany, any regulation for promoting smoke prevention. Suggestions are offered for compliance with smoke abatement.

1949

Describes the purpose, method, and results of education of railroad employees in operating railroad equipment. Changes in operation to aid in the smoke-abatement program by the railroads have made it necessary to give instruction in the new methods. The results are that the education has more than helped in every way in abatement of smoke. Air pollution as an educated man is an "abating man."

Railroad smoke can be controlled only when the railroad assumes the full responsibility for proper tools, well-maintained equipment, and proper operational conditions. When the fire tenders take it upon themselves to do a job of controlling smoke, then and then only can it be done. When our smoke-control programs have educated our railroad personnel, from top to bottom, that the control of smoke emitter is as vital to railroad in its public relations as its safety program, then we will look forward to a measure of sustained success in holding the emission of dense smoke to an irreducible minimum.

Overfire air jets for reduction of railroad smoke by increasing combustion efficiency are discussed. It is one of the most effective tools available for reduction of smoke in operating steam locomotives.

Describes a smoke eliminator for locomotives that has been used with good effect on industrial locomotives. The apparatus introduces a flow of turbulent heated air above the fuel bed in the firebox to complete the combustion of smoke-producing gases before they are drawn into the boiler tubes of an engine. The eliminator can be operated as required by the driver, or it can be arranged for automatic operation in conjunction with the regulator. Additional equipment has been developed so that the smoke eliminator can be controlled automatically in conjunction with the regulator on large locomotives engaged on main-line work. (FA)

Great progress has been made toward eliminating smoke on the railroads in Milwaukee County while retaining amicable relations with the management and personnel of the railroads. A statement of policy regarding smoke violations is made. It is emphasized that the ordinance calls for smoke abatement and control, not for complete elimination, which would be ridiculous. The impossible is not expected.

Discusses steam-generating equipment of a fixed nature while the locomotive is at its terminal for servicing and that of a movable nature while it is enroute from one terminal to another. Describes methods of firing and equipment available for preventing pollution of the atmosphere by railroad locomotives.

Discusses smoke abatement from the standpoint of railroad handling. The railroads have spent much money in the cause and prevention of smoke and fly ash. Under the proper conditions, any fuel or combustible material can be burned smokelessly. The problem is an application of sound engineering principles. Probably the most important thing to be considered by the railroads is the human element. The smoke laws...
or ordinances are public demand and will be permanent. The only way the railroads can comply with the requirements is by educating railroad employees who handle fires in the proper way to build and maintain them without making smoke or at least cutting smoke down to a minimum. As the community, the municipal authorities, and the law makers are educated in the problems of air purification, the laws and ordinances that are passed will be obeyed by everyone.


Discusses relations of this railroad with the different cities for complying with the smoke-abatement ordinances they have adopted. Each city has a different smoke-abatement law, yet they all have the same meaning. The system used in handling the locomotives in Louisville, Nashville, and Birmingham is described. The railroad handles its own smoke violations when they are reported to it by the city. The fullest cooperation is given in helping put over the smoke-abatement program of these cities.


Discusses briefly the success of the smoke-abatement program in Cincinnati as a result of the cooperation of the railroad companies in appointing a joint supervisor of locomotive operation and giving him authority and men to work on the program. As a result railroad officers go to Cincinnati from other sections to learn how to control smoke, and the educational program with the engine crews is described. Although the above equipment assists in reducing the smoke emission, the successful operation depends upon the personnel. An educational program was set up in each roundhouse, and the firemen were instructed in the proper method of using the appliances mentioned.


Outlines the general progress made in railroad smoke control on the part of the two largest railways operating in the Dominion of Canada. The problems of the Canadian National Railways are discussed in part 11. The railroad smokeoffenders are reduced approximately 70 per cent, partly by replacement of 125 steam switching engines by 76 diesels, and partly by the heavy cooperation given by the railroads entering the city. Statutory laws reduced their smoke by 25 or 40 percent. Power users invest some $3,000,000 to insure smokeless operation.


Discusses improvement made by British railways in design of dampers and fire-hole doors to ensure satisfactory supplies of primary and secondary air and of brick arches to ensure adequate turbulence and combustion over the fuel bed. A fairly recent innovation is the fitting of a screen, which tends to equalize the blast suction over the face of the front plate and thus reduce the amount of unburnt fuel lifted off the fire bed. The art of firing and the possibility of using smokeless fuels have been studied. Schemes for pre-steaming are being prepared, and locomotives are being fitted with cockers to permit pre-steaming should it be adopted as a policy. Ever since the advent of the locomotive-running departments goes through a systematic course of training and has constant opportunities for refresher courses.


Mechanical improvements that will be standard equipment to help in the effort to abate smoke on the railroads operating in Milwaukee County are described. Considerable success has followed the efforts to abate smoke and comply with the regulations of the Milwaukee County Department of Smoke Regulation.

The steam jet, sealed arches, and the ring blower are some of the equipment that has been installed. However, no mechanical equipment can take the place of constant vigilance by the engine crew and proper maintenance of the locomotives.


The goals set by 26 cities to be reached by the railroads in smoke elimination are discussed. The major methods given for reducing smoke are summed up as constant observation and reporting of violations (some referred to this as constant pressure for better performance, or never being satisfied with the present record) and fostering a cooperative spirit between the city and the railroad for top smokeless performance. Close supervision or maintenance of power to ensure that mechanical equipment is in perfect condition is given as very important. Close supervision of operating crews and insistence that firemen observe accepted firing practices that have been proved effective are also factors. Other points include the use of smokeless or low-volatile coal on switching locomotives, the use of specially selected (double-screened) coal, fostering of educational programs, use of the monthly award system to instill competition among the roads, periodic meetings with city officials, reporting of good performance as well as bad, and adequate mechanical equipment.


Philadelphia is placed third only to Los Angeles and Cleveland in its achievements during 1949 in cutting down the smoke nuisance. This was due to the cooperation of the railroads and users of stationary power with the city division of air pollution.

During the period railroad smoke offense was reduced approximately 70 percent, partly by replacement of 125 steam switching engines by 76 diesels, and partly by the heavy cooperation given by the railroads entering the city. Statutory laws reduced their smoke by 25 or 40 percent. Power users invested some $3,000,000 to insure smokeless operation.


The statement is made that in Chicago in an area of 216 miles, 25,000,000 tons of coal a year is burned. A big problem in Chicago is the home owner who, having an oil- or gas-fired furnace, burns up in the yard all his weeds, paper, and other accumulations around the house.

The railroads are proud of their record. The number of violations in Chicago in 1947 was 4,190; in 1948, 2,713; and in 1949, 1,313. Railroad smoke violations per 100 working hours of coal-burning locomotives have dropped 30 percent since 1947. The principal factor in controlling railroad smoke in Chicago has been the increased use of diesel and electric power and a corresponding decreased use of steam power. In 1945 as total locomotive hours was 5,650,000, of which 41 percent was diesel; in 1948 the number dropped a little to 464,960, 52 percent of which was diesel; in 1949, the number of hours was 415,580, with 69 percent diesel.

As far back as 1913, the city developed a program for controlling smoke. The railroads, naturally, were a contributing factor to the smoke, which even then was objectionable. This 1913 program proved to be ineffective. Sporadic efforts have been made since that time to improve conditions, particularly in the years 1929 and 1939, in all of which the railroads cooperated. With the results still unsatisfactory, the city passed an ordinance on April 30, 1946, which gave an impetus to the program.

At this time the railroads were recovering from the effects of World War II, which prevented them from obtaining immediately the desired results, because of inability either to acquire the necessary material in volume or to equip locomotives with mechanical devices for controlling excessive smoke. The interest of employees had also deteriorated, and the railroads were faced with an educational as well as a mechanical problem.

Since the ordinance has been in effect the railroads have reduced the objectionable smoke approximately 90 percent.

The various measures taken to solve the problems connected with smoke blight are outlined. The major improvement is due to proper supervision, adequate education of employees, and cooperation from employees.


Consider some of the smoke-abatement problems confronting the Canadian National Railways and the methods employed during the past 2 years in achieving fairly satisfactory results. The Canadian Railways are fully aware of the importance of reducing smoke emission to the atmosphere, and are endeavoring to improve the situation not only in Montreal but also in all towns and cities in Canada.


Sources of smoke in running sheds, stations, tunnels, and shunting operations are considered, and some past efforts to reduce them are described. Direct steaming, improved methods of lighting up, use of overfire jets during running, provision of hot-water washing systems in running sheds, and staff training and discipline are advocated as methods of meeting present needs. (APB)

1951


Smoke problems caused by coal-fired steam locomotives are discussed briefly. The main problem occurs during the firing in roundhouses. Application of portable air jets, or "forks", during lighting up has given good results.


A research and development project aimed at reducing the particulate pollution resulting from fly ash and cinders emitted from steam locomotives is making important progress, according to Bituminous Coal Research, Inc. This research is jointly sponsored by the railroads serving Allegheny County, Pa., and the bituminous-coal industry through the research agency.

The project was initiated in 1949 to develop methods by which railroads could comply with the provisions of a new smoke ordinance. The specific objective was research on the design, construction, and testing of a cinder- and fly-ash collection and disposal system suitable for conventional steam locomotives, which would reduce stack emission of solids 75 percent by weight.

Performance tests with conventional collection and reinjection methods reduced the stack emission about 50 percent by burning part of the carbon in the coarse reinjected cinders on the grate. Since this percentage reduction did not meet the objective of the research, it has been necessary to explore all possible methods through which a further reduction in stack emission could be made.

A promising approach is now being explored. Equipment will be tested to determine whether the remaining cinders can be reduced to a size that will permit the carbon content to be burned within the space limitations of the locomotive firebox.


Measures are discussed for smoke abatement by the railroads. Smoke produced by coal-burning equipment on the railroads can be controlled to a point where it will not be really objectionable if equipment is maintained properly, fuel of reasonably good quality is furnished, and supervisors will not condone unnecessary smoke at any time.

1952


The Minister stated that modification of a mobile locomotive boiler had been ineffective. Smokeless fuel would now be used when the boiler is working in residential districts. (FA)


Big-city railroad yards are source of serious air pollution. One of Canada's largest railroads has eliminated this nuisance at a new freight terminal yard in Montreal by direct steaming of coal locomotives from recently built central steam plant.

This plant not only eliminates the major causes of air pollution in freight-yard operations but also makes sure that main-boiler operation is above suspicion. Aside from the better public-relations value, substantial fuel savings result, together with reduced locomotive-boiler maintenance, reduced fire hazard, a saving in enginehouse labor, and more rapid servicing of the engines.


Various developments in firing locomotives during the years are mentioned.

Desielization of all railroads has answered most of the air-pollution problems, but there are still steam locomotives and power plants and therefore there is still a smoke situation and fly ash to contend with.

The progressive and substantial improvements made by the railroads during the recent years is due in great part to the uniring efforts of supervision, along with the cooperation of the air-pollution engineers and smoke inspectors. Engineers have done a great job in helping to educate new men. During the war periods when the railroads had to hire most anyone who desired
NATURE AND ORIGIN OF POLLUTION

a job, it was a great task for the supervision, and the older men in service aided the supervision considerably. Smoke abatement is not only a transportation problem, but a maintenance problem as well. The locomotives have to be properly maintained to abate smoke. The New York Central Railroad not only blows the flues at completion of each trip, but washes the flues every 30 days or on monthly inspections. This gives cleaner flues, better draft, and helps prevent smoke. All New York Central locomotives are equipped with smoke-eliminating devices. Engine houses are all supplied with smoke-elimination devices for their power plants, and most all stacks are equipped with the electric eye. Also, they use air forks and air torches to fire up locomotives. All roundhouses are instructed to use some sort of banked fire. Some points use the horseshoe method, others the cross bank, but any type of bank in firebox in building a new fire is good, if properly applied. It takes education along these lines to abate smoke. Coordination and the willingness of all concerned to do the job right and make smoke one of the greater offences on the roads is needed. The Superintendents Committee appointed a Joint Engineer, to cope with the problem for all the railroads.


Presents record of the progress in eliminating air pollution from railroads in the District of Columbia from 1933 to 1951. Results show what can be done by co-operation between great corporations and a municipality where there is a real understanding of each other's problems and a desire to reach a common goal.

This is the swan song of the coal-fired locomotive in the District of Columbia. Of the 6 roads now operating in the District, 5 are 100 percent electric, except for extra sections or specials. The sixth has all freight and switching service and 50 percent of its passenger service dieseled.

Measures taken to solve the problem of air pollution from railroads are discussed.


What Canadian railroads are doing to reduce the smoke nuisance from steam locomotives is discussed. The majority of the smoke problem as it exists in Canadian cities is encountered in roundhouse operation. A great deal of attention is concentrated on this phase of railway operation. Considerable success has been attained in reducing the smoke nuisance by diligent supervision, disciplinary action, and adoption of all known improved methods and devices.


Reducing atmospheric pollution by the railroads will require not only utilization of suitable engine fuel and technical improvements in combustion and air distribution but above all, the railroad employees, from top to bottom, must become air-pollution conscious. Smoke and fly ash are no longer fashionable. Locomotives are conspicuous targets of public criticism whether they belch smoke in the cities or along the country highways. The fraction attributable to the railroads is always far greater than their share of total atmospheric pollution, but until they are ever smoke conscious and ever vigilant, they will be vulnerable to excessive criticism.


The contribution of battery electric vehicles to maintenance of clean atmospheric conditions and their advantageous operation as compared with that of vehicles with internal combustion engines are discussed. (APB)


The invisible gases resulting from combustion, from process and from engines are said to be a more dangerous air pollution than smoke. Many ordinances are considered unreasonable in that they purport to have been enacted to eliminate air pollution and merely legislate against smoke of certain shades and colors. (APB)


Demands for smoke control began in Cincinnati soon after 1900, and in 1913 the city passed a strict law. The Cincinnati Superintendents Committee appointed a joint Supervisor of Locomotive Operation, with an adequate staff, to cope with the problem for all the railroads.

In 1914 Cincinnati began to prosecute smoke violations in the courts, and until 1926 the fines reveal a continuous fight between the city, the railroads, and the brotherhoods. Enginemen were jailed, fined, suspended, and dismissed but there was not much improvement.

The general managers and superintendents met with the mayor, the city manager, and the chief smoke inspector in 1926, and worked out an agreement placing the responsibility in the hands of the railroads. Smoke violations observed by the city inspectors would be sent to the supervisor of locomotive operation who would handle matters with each road for investigation and discipline under the practice current on that road. A satisfactory reply would be rendered to the chief city inspector. The railroads engaged themselves to reduce the violations below 2 percent of the observations made by the city inspectors.

The new plan worked, and this may be fairly said to be the birth of real smoke control in the Cincinnati terminals. The management made it mandatory that every supervisor make it an important part of his work to teach his own men to handle engines without objectionable smoke.

There are smoke violations, and there are complaints from the public through the various sources mentioned. New men, defects that show up after engines are dispatched, and the occasional slip-up of the best men require hard work to maintain and improve the smoke record in the Cincinnati terminals. The fact remains that with the help of all the men on the railroads, a proud record of smoke control has been established.

STEAMBOATS

1860


Letter, advocating use of blast on board steamboats for generating steam and preventing smoke, with editorial commendation of the suggestion. (MIR—Bib.)

1905


Gives brief remarks and a number of photographs showing a slight production of smoke during official trial. (MIR—Bib.)
AIR POLLUTION—A BIBLIOGRAPHY

1913

571. ENGINEERING RECORD. Regulating Smoke on River Steamboats Within City Limits. Vol. 67, 1913, pp. 223-224.
Investigation being made on the production of smoke on the Ohio River at Cincinnati. Combustion tests were made on boiler furnaces of river boats. Government investigation is recommended. (MIR—Bib.)

1928

Conditions largely applicable to Paris are considered. The importance of atmospheric pollution is emphasized by the statement that we absorb daily a weight of air six times as great as the food and drink we consume. The production of smoke, dust, and deleterious gases is avoidable.

The navigation of the Seine is a fruitful source of smoke, tugs being some of the worst offenders. The following rules are proposed: No steamboat during the passage through Paris should be allowed to give off thick or notably colored smoke, except accidentally and for a brief period, the same to apply to floating cranes, dredges and the like; floating baths and laundries should either burn coke or give off no more than if they burn this fuel.

With regard to railways, electrification, especially in the cities, is the ideal. Pending this, three steps can be taken: (1) Coke could be used in shutting locomotives and on suburban lines. (2) Great nuisance arises from the firing up of locomotives in the roundhouse. The installation of a central heating plant, which would deliver to outgoing locomotives water at a temperature of 95° C. and would receive the hot water from returning engines, would go far to prevent this nuisance and would effect considerable economy. (3) Stokers should be instructed that "the smoking chimney means a cooling furnace." (BJ)

1937

Reference is made to the international aspects of smoke abatement. Not many years ago ocean passenger steamboats were designed and built with a multiplicity of smokestacks, and all the stacks were expected to emit large volumes of dense smoke. Conditions in regard to smoke emission in New York Harbor were deplorable. From time to time various methods of attacking the smoke problem were proposed, tried, and discarded. Violators of smoke ordinances were prosecuted and fined.

Excellent results have been attained since the organization a few years ago of the Marine Smoke Association of Hudson County, N. J. The tremendous reduction in air pollution due to smoke in New York is the natural result. This result has been achieved without prosecutions for violations and consequent resentment. This is a good record and indicates the efficiency that can be obtained when intelligent thought and reasonable care are applied to the problem of smoke abatement.

1946

A preliminary report of an investigation, conducted in a wind tunnel on model ships, to determine what principles must be followed in the design of stacks to insure that the products of combustion stay clear of the ship once they have been discharged. (FA)

1947

575. FUEL RESEARCH TECHNICAL PAPER. Reduction of Smoke From Merchant Ships. Trials Carried Out in SS. Ocean Vista to Test Other Burners. Fuel Research Station reported in 1947. The Oceana Vista is a cargo vessel of 7,174 gross tons and is propelled by triple-expansion machinery (developing 2,500 l. hp. at 76 r. p. m.) supplied with steam by three coal-fired Scotch marine boilers, each of which has three furnaces fitted with an American version of the Howden forced-draft furnace. Trials were made with a light cargo (at 13 knots) and with a 10,000-ton cargo (at 11 knots), each trial lasting 3 1/2 days; the vessel carried her ordinary crew. The coal used during the trials was a 50 : 50 mixture of Rossington cracked hard and washed doubles. The smoke eliminators were a controllable additional source of secondary air, which was turned on soon after firing and raking in order to prevent smoke formation (from "naked" tarry vapors) and loss of combustible gases. For the trials the two wing boilers were fitted with all the instruments necessary for a comprehensive boiler trial; during the trials the smoke eliminators were employed on one boiler at a time, the others operating without them. A number of funnel-gas analyses were made. The loss of potential heat without smoke eliminators was about 10.5 percent, and with them it was about half as much. Average boiler efficiencies were about 60.8 percent without the eliminators and about 70.7 percent with them, showing a saving of about 5.9 percent of fuel for the same amount of steam. Results are given in full. (FA)


The mechanism of smoke formation is outlined, and the role of overfire jets in reducing it to a minimum is discussed. Sea trials of SS. Ocean Vista, in which each of the three hand-fired, 238-hp. Scotch boilers was equipped with two smoke-eliminator nozzles of the type that had shown substantial fuel saving in tests conducted by the Fuel Research Station of the Department of Scientific and Industrial Research, are described. Examples are given of the application in America of overfire jets to steamboats. (APB)

A method of increasing turbulence and thus improving combustion in the fire-tube boilers of steamboats is described, and applications to other types of boilers are suggested. Hollow finger-type air boxes are mounted on an air manifold across the back of the fire bridge, and holes in the back of each finger discharge air onto solid rods that set up turbulence. The parts must be able to withstand an oxidizing temperature of about 2,000° F, and their incandescence further assists good combustion. (FA)

1948


In May the Port Health Authority drew the attention of the owners of tugs operating in the port to the increasing nuisance from smoke, warning them that proceedings would have to be taken unless an immediate improvement. Arrangements are being made for all cases of black-smoke emission to be investigated, and in one instance the issue of a statutory notice has been authorized by the authority. (FA)

Brief reference is made to the Howden vortex system of dust and soot extraction from funnel gases, which has been applied with satisfactory results to vessels of the principal British and foreign shipowners. It consists of one or more cylindrical chambers, which can be fitted in the uptakes in any convenient position between the boilers and the top of the funnel. The gases enter at the bottom of these chambers and are made to rotate upward and tangentially by an arrangement of fixed vanes. This sets up a vortex within the chamber, and the particles of soot and grit are thrown out by centrifugal action to the periphery of the collector. There are alternative methods of extracting the dust. (FA)


On board ship weight and space limitations require that the boilers and fuel-oil burning equipment be designed to be lightweight and yet simple and highly efficient. The importance of smokeless combustion of fuel is stressed.

The design and efficient operation of marine boilers and fuel-oil burners are discussed.


Smoke has become something definitely not wanted on board ship by the passengers and by the dwellers in coastal cities and along rivers and lakes. In addition, smoke represents a waste of fuel and a costly loss of efficiency, which is becoming more noticeable as the rising cost of fuel. As a result, considerable effort has been expended to eliminate smoke in marine installations.

The design and construction of marine boilers and their operation are discussed. In addition to the nuisance value of smoke, there is also the problem of fire hazard. Properly controlled and virtually smokeless firing at all rates of operation is the most effective way to eliminate this fire hazard.


In the operation of one shipping line new methods of improving the cleanliness and efficiency of boilers are being experimented with successfully. Excessive fuel consumption is reflected not only in high operating cost but also in lower revenue. The greater the amount of fuel carried, the less cargo is carried, with a resulting loss in revenue.

The firemen are reminded constantly of the necessity for keeping all adjustments in order to prevent smoke.

1950


The Engineering Advisory Committee of the Great Lakes Air Pollution Abatement Program reported that the second phase of the program has made thoroughly satisfactory progress. This phase consisted of two-men teams making observations and collecting data on representative lake vessels relative to the cause of smoke; recommendations were made as to the best way of controlling this problem.

The first and most essential phase was fuel specifications.

Very real assistance was rendered by the fuel and combustion engineers in the second phase of the program.

Battelle Memorial Institute has been engaged to make a detailed analysis and interpretation of the results of the research work accomplished for the purpose of making specific recommendations to correct the smoke nuisance from Scotch marine boilers.

The first phase of the program has been generally complied with, and considerable improvement has been noted aboard ship.

It was decided that considerable education work among both management and crew members should be undertaken immediately. In the near future various equipment manufacturers concerned with the design and installation of boilers and fuel-burning equipment will be included in the program.

1951


Smoke from the boats plying the Detroit River and other sources of air pollution in the Detroit, Mich., and Windsor, Ontario, area has been so extensive that an international study has been launched to analyze the causes, effects, and possible controls for air pollution.

In January 1949 the Governments of the United States and Canada requested the International Joint Commission to explore the situation. A Technical Advisory Board on Air Pollution was given general direction to the field work and to plan the studies both on the Canadian and American sides of the boundary, to review the findings periodically, to discuss the significance of the data accumulated, and to make recommendations to the International Joint Commission.

The objectives, which are long-range goals, are briefly: (1) Determination of sources, nature, and amounts of atmospheric contaminants resulting from combustion of fuels; (2) determination of sources, nature, and amounts of atmospheric contaminants resulting from industrial processes; (3) determination of effects of local meteorological factors on the dissemination and diffusion of atmospheric contaminants; (4) determination of the effect of the atmospheric contaminants upon (a) health, (b) vegetation, (c) safety, and (d) economy; (5) determination of controls necessary, their cost, and by whom the cost should be borne.

The investigations to date include analysis of stack effluent, observations of smoke emission from vessels, studies of data obtained by questionnaires and preliminary meteorological information, formulation of comprehensive plans for epidemiological studies, and development of cooperative relationships with various Federal, State, or Provincial and municipal agencies.

1952


The manufacturers of the F. C. M.—Valensl "Strombos" funnel have recently taken out a British patent for a modification of the device, which retains the principle of ejecting the smoke into the tip vortex of a casing shaped like the half wing of an aircraft. In the modified form, however, the unconventional shape of the top of the casing is abandoned in favor of one of more usual appearance. The funnel comprises an outer casing in the general form of an aerofoil. The top of this casing is flat and horizontal and is completely closed. The smoke flute communicates with the exterior through a pair of horizontal output channels arranged one on either side in the upper part of the funnel. These channels point aft, their walls making an angle of some 30° with the outer surface. It is stated that a satisfactory guiding effect is obtained for the smoke jet, however high the rate of discharge from the flare outlets may be. (FA)
COMPOSITION OF AIR POLLUTANTS


The action of sulfuric acid content of vitiated air is thought to be much less harmful to vegetation than the injury caused by the fixation of "black smoke" or soot upon plants. (MIR—Bib.)

1889.


Summarizes section of report of chief inspector under the Alkali Act. Concerned mainly with the presence of harmful gases and with the composition of smoke. (MIR—Bib.)

1891.


Gives particular attention to estimation of sulfuric acid in the air and to general composition of soot deposits. (MIR—Bib.)

1893.


The various substances found in London urban fogs, which have become polluted by smoke, are discussed. The sulfuric and sulfururous acids are conceded to be the important noxions elements, although other substances are believed also to have a deleterious effect on plants. These include hydrochloric acid, ammonia, metallic iron, ferric oxide, hydrocarbons, phenol, and some of the members of the pyridine series.

Various types of injuries to plants, such as discoloration and disarticulation of the leaves, are mentioned. The type of damage peculiar to each type of plant is also discussed. The loss of light due to air pollution is discussed as another contributor to plant injury. (USPHS)

1895.


Proves that the greater part of the sulfur on burning lighting gas is transformed into SO₂, and 93.3 percent of this SO₂ is changed in the absorption liquid to H₂SO₄.


1897.


Method made use of zigzag tube coated with vaseline, through which air was aspirated, with cotton-wool plug as filtering medium. Amount of soot determined by weight. (MIR—Bib.)

1901.


Nordenskjöld described two kinds of dust collected by him from Arctic ice: (1) Diatomacéa and (2) felspathic sand. The third was probably from interplanetary space.

Professor O'Reilly gave to authors: (1) Solid matter carried down with hail and collected at Stephen's Green, Dublin: (2) solid matter carried by hail and sleet onto the window sill of the Royal College of Science, Dublin; (3) pumice from Krakatoa.

(1) Contained Fe, Na, Pb, Cu, Ag, Ca, K, Ni, Mn (Ca and Co?).
(2) Contained Fe, Ca, Na, Pb, Cu, K, Mn, Ni, Ag, Th (Ga, Ru?).
(3) Contained Fe, Cu, Ag, Na, Ni, K, Rb, Mn, Ga, In, Sr.

With the exceptions of Sr, Ni, and Co, the authors found the same constituents in 97 iron, ores, and associated minerals. In six meteoric irons they have found the same constituents, with Ni and Co, the latter invariably in smaller quantity than the former.

(Tables of spectroscopic observations are given and explained.)

The authors present two conclusions: (1) The presence of Ni is not certain evidence of extraterrestrial origin; (2) the dust that fell on calm nights, Nov. 16 and 17, 1897, very probably was cosmic.

Attention is called to the distribution of Ga (all minerals, fine dust, soot, air dust, iron ores, and bauxite). They hope to find it concentrated in some mineral, as are Th, Cs, Ge, and In.

1902.


1905.


From Memoirs and proceedings of the Manchester Literary and Philosophical Society. Gives method of examination and extraction of constituents. (MIR—Bib.)

1906.


Tests on conductivity of smoke. (MIR—Bib.)


Investigations of air of towns and country districts have shown that the amounts of sulfurous and sulfurar...
acids in the air always increase in foggy weather and are normally present to a much greater extent in urban than in rural districts. (MIR—Bib.)

1909


Describes aspirator and testing apparatus used for determining carbon dioxide and oxygen. A bonus system for rewarding careful flemen is based on percentage of gases resulting from combustion. (MIR—Bib.)

1911


Soots analyzed were taken from different parts of Leeds. Estimates are given of amounts of soot deposited and its effect on vegetation. (MIR—Bib.)


Composition of finest particles are determined by spectroscopic and photographic observations. As no analysis is free from dust and city air is particularly dusty, the various mineral constituents must be regarded as possible reagents in instances where there is evidence that very minute quantities of basic substances can initiate chemical reactions. (MIR—Bib.)


Considers nature and composition of smoke from metallurgical works, its prevention, methods of precipitation and of utilization of heat, and constituents of smoke. (MIR—Bib.)

1913


Shows prevalence of sulfur in smelter and other fumes and harmful effect on animal and plant life. Suggests methods for overcoming nuisance. (MIR—Bib.)

1920


Gives results of tests of Salt Lake City atmosphere to determine presence of sulfur dioxide from smelters. 1931


This report and discussion of the Meuse Valley catastrophe of December 1930 states in part: "The sulfuric acid is present in the air as minute liquid droplets of dilute sulfuric acid, condensed on solid nuclei, while the sulfuric acid is present as a gas. These particles are evaporated to a much greater extent inside buildings, though acid nuclei still remain and make the air inside just as irritating as that outside. Many Liège victims had never been outdoors at all." 1932


A study was made, extending over 18 months, of atmospheric pollution at Bordeaux, where sulfuric acid and hyperphosphates are manufactured. The investigation, an interesting one, shows how the air may be polluted by sulfur dioxide, chlorine, nitrous fumes, and fluosilicate of iron emanating from industrial processes. Air pollution with sulfur fumes is provided with efficient apparatus for absorbing the harmful fumes. At the same time, other industries pollute the atmosphere with soot and sulfur fumes, which are harmful to food and habits. Motor cars give off carbon monoxide, and the combustion of organic waste generates objectionable odors. The domestic fire is another source of pollution. All these injurious fumes can be and should be prevented. The appointment is suggested of inspectors to insist upon certain means for their prevention being observed. A short code of regulations for this purpose is suggested, among which fumes arising from wood fires used by bakers are tolerated as being harmless. (BIB)

1936

608. Ruskin, S. L. Pollution of the City Air as a Source of Nose and Throat Disturbance. Science, vol. 84, 1936, p. 84.

Air pollutants are principally sulfurous gases. Others are hydrochloric acid, chlorine, hydrofluoric acid, oxides of nitrogen, ammonia, hydrogen sulfide, carbon disulfide, carbon monoxide, formaldehyde, and hydrocyanic acid. The source of oxygen is principally plant life and animal sun rays. Plant life may be a measure of air pollution, as plants are more susceptible than humans. Meteorological aspects are discussed, since calm days tend to concentrate dust and smoke over the exposed areas. Presence of dust or soot is necessary for condensation of moisture to produce fog. Reduction in the temperature and the absence of wind are also factors in its production. Fog then is a source for prolonged inhalation of noxious influences. These cause a prolonged irritation of the respiratory tract, with an increased susceptibility to respiratory infections.

The importance of city planning with regard to prevailing winds, so that the location and number of industrial stacks as well as volume of gas expelled therefrom may be controlled, is stressed. (USPHS)

1939


Methods of graphical estimation of dewpoints are presented. The graphs and tables are a very essential part of the presentation and should be referred to in the original article. The graphs show the relation of the amount of water vapor in flue gases to the dewpoint, theoretical dewpoints of the flue products of industrial fuels, and the effect of sulfur on the dewpoints of the flue products of solid, liquid, and gaseous fuels. The tables give sample calculations of dewpoints for solid, liquid, and gaseous fuels as well as the analyses of different types of coals, fuel oils, and fuel gases.

1937


The common fallacy of blaming all fogs on smoke is mentioned, although it is known that fogs can be just as thick in the Atlantic as in England, with a difference in color. It is usually claimed that the house fire is the chief offender in the production of soot. If this is true, it may be argued that the black deposit in rainwater, which is claimed to be chiefly soot, would be much greater in winter than in summer, but the opposite is true at Leeds. The public should realize that invisible smoke possibly is more dangerous than visible smoke and that atmospheric pollution is, in reality, a biological rather than a chemical problem.
1939


Summarizes published investigations on amount of sulfur compounds existing as damaging pollutants in air. Gives data on Chicago, Detroit, Philadelphia, Pittsburgh, Portsmouth (Va.), St. Louis, Salt Lake City, San Francisco, and Washington, among cities in this country, on Berlin, Liege, Budapest, London and several other British cities, and Prague, among cities abroad.

1940


To determine factors embodying corrosion in an essentially industrial area and an essentially residential atmosphere, a series of low-carbon structural steels and wrought-iron coupons were placed at a point in downtown St. Louis, near the river, railroads, and areas of low-efficiency heating plants. Another group of the same metals was placed on the campus at Washington University. The samples were carefully measured and weighed as scale-free pieces, and periodically a set was brought into the laboratory, where the scale was removed. Clean sample coupons were weighed, and the amount of metal computed. The samples were set in racks at an angle of about 45°, with the horizontal end facing south, so that the top side would receive the maximum sunlight and the bottom side the minimum.

In summation of the results of this series of samples subjected to the smoke of industrial and low downtown areas and to that of the campus of Washington University, it is evident that for these pieces of structural steel and wrought iron, the atmosphere on the campus was less corrosive, presumably because a less sooty and sulfurous fuel was burned in the immediate neighborhood. Weather conditions were approximately the same in both locations, and all samples were taken out of the same strip. The appearance of the samples during the progress of their corrosion indicates that the mechanism of the attack is identical for all of them. This is reflected to some extent in the curves showing metal losses. No checks were made upon either the soot or sulfur dioxide contents of the air at the two locations, although the citizens of St. Louis know that there is a difference of pollution in the two locations.

A direct observation is that a polluted atmosphere is, among other things, a waster of natural resources; the estimates of annual costs of corrosion mentioned could be reduced materially by a cleaner atmosphere. It is hoped that this talk may serve to emphasize another reason for the desirability of an unpolluted air.

1941


In one instance, the waste gases of a burning dump of a mine were judged disagreeable but not injurious to the neighborhood. In another H₂S was found in the gas of a burning dump in such quantities that injury to nearby inhabitants was possible. In the third, the SO₂ content was injurious. Gases from a galvanizing plant were found to be innocuous for the neighborhood. (JHIT)


Examination of a continuous record of SO₂ concentration of the atmosphere shows: (1) a daily cycle in which SO₂ concentration increases during the day and falls off in the evening during the winter months; in other seasons the drop occurs in the early afternoon as a result of northerly breezes. (2) A weekly cycle for fall and spring; concentration of SO₂ is low on Sunday and Monday and increases by about 50 percent to a maximum on Thursday and Friday. (3) An annual cycle, which follows a sine-shaped curve, with a minimum of 15 parts of SO₂ per thousand million parts of air in summer to a maximum of 50 parts in winter. The data were studied with reference to the correlation of SO₂ concentration with wind direction and velocity, temperature, and rainfall. (JHIT)

1942


The nature and harmful objectionable aspects of atmospheric contaminants are discussed. Although some gaseous contaminants are mentioned, the paper is mainly concerned with the sampling, concentration, composition, and size properties of the particulate matter found in atmospheres. This particulate matter is termed "dispersoids"; various ways of collecting and classifying these pollutants are suggested. Among suggested sampling methods are settling, washing, impinging, electric precipitation, and thermal precipitation. The concentration of dispersoids both by direct and indirect methods is discussed, as are methods for determining their composition and size properties. Suggestions are made for the collection of comparative information relative to particulate atmospheric pollutants. (CLAC/UCLA)


Analysis of samples of organic and inorganic particles in the atmosphere of Buenos Aires included the determination of the number, size, and chemical nature. The samples were collected at 180 cm. above the ground, on clear and sunny days, and placed on a plaque of quartz covered with a thin film of gelatin. The air was first filtered through a copper screen, which allowed only the particles smaller than 100 μ to pass through it. The air current was maintained uniformly in all tests at a velocity of 86 cm. per second. In the center of the city the particles of organic origin were predominated; this fact was attributed to motor traffic, heating systems, and factories. In the outskirts districts, with less traffic and poor pavements, the particles of mineral origin predominated. (JHIT)

1943


In 1936–38 the iodine content of air at Stuttgart was studied. The relatively high values obtained were attributed to an increased quantity of seaweed in coastal areas, and the content of iodine in Stuttgart air was found to vary with the direction of the wind. At present there is not as much seaweed, and it was interesting to find that the iodine content of the air is also lower. In 1937–38 as much as 11.3 μg. of iodine was sometimes present in 100 m.³ of air, with an average value of 3.66 μg. In 1941 the highest value found was 6 μg. and the average value was 2.25 μg. As in previous studies, the iodine content was greatest when a west wind prevailed. (JHIT)


The pollution found in towns can be divided into three classes: (1) Smoke, (2) Sulphurous gases. In addition, a reduction of daylight, particularly ultraviolet light, which is greater in the winter.
than summer. Air is cleanest in early morning; smoke increases rapidly, reaching a maximum in the middle of the morning. The highest pollution is found close to the center of the city (Lecentre) rather than some distance downwind. Even in strong winds the maximum number of particles was found very close to the center of the city. The removal of smoke is affected by (1) diffusion across wind direction, (2) deposition, and (3) spreading upward. The third factor is the important factor. As Sunday pollution in the center of towns is roughly \( \frac{1}{2} \) to \( \frac{3}{4} \) of weekday pollution, smoke pollution is \( \frac{1}{2} \) domestic and \( \frac{1}{2} \) industrial in origin. The problem of counteracting pollution is discussed. (JHIT)

1946


Literature dealing with the composition, mode of formation, and chemical and physical properties of dusts carried by flue gases and with the behavior of dust in boiler installations is reviewed. Dedusters and smoke emission from stacks are also considered. A bibliography of 98 refs. is given. (FA)


The author stresses the advantages for many engineering applications of expressing the size characteristics of dusts in terms of terminal velocity rather than particle diameter. The actual terminal velocities are often of great practical importance; while these can be related to diameters through Stokes' law, large errors may be introduced through variations in the shapes and densities of the dust particles. "Inches per minute" is suggested as a convenient engineering unit for expressing terminal velocities of dust particles in air. (FA)

1947


The composition of smoke, its origin, disposal, causes, and effects; its prevalence; methods of measurements; and the remedial measures available are discussed. Comments are made on the widely variable composition of "smoke" and the great variation in the quantities of material suspended in and deposited from air under different circumstances. (FA)


Although the behavior of flue dusts in air or any other fluid and the ease with which they can be separated from an air stream are often expressed in terms of particle diameters in microns, this relationship is based on Stokes' law which assumes that the particles are spherical and of uniform density. As most industrial dusts are a mixture of particles of irregular shapes and varying densities, the importance of considering the effect of all particle characteristics—size, shape, and density—upon its behavior in a fluid is indicated. The terminal velocity of a dust particle is also shown to measure the combined effect of all three particle characteristics as they affect its behavior. (APB)


Experimental data are presented for the composition of the flue gases and the weight and composition of the suspended matter carried by them when producing smoke of measured optical density in a Lancashire boiler and in a side-draught furnace boiler under both forced draught and natural-draught conditions and in a domestic fire. The coal used ranged from weakly caking to strongly caking. These data, which are presented in graphical form, indicate that, as might be expected, the composition of the suspended matter varies with furnace conditions. For example, a "distillation" smoke contains more tarry material than "cracked" smoke due to the lower optical density. Nevertheless, all the fuels and all methods of firing, the weight of suspended matter per unit volume of flue gases was approximately proportional to the optical density of the smoke. There was also a marked similarity in the general trend of curves showing the percentages of carbon monoxide and of hydrogen present in the flue gases and the optical density of the smoke made under the various conditions. The magnitude of the various heat losses due to incomplete combustion was examined, and it is noteworthy that the heat lost in the invisible gaseous constituents of the flue gases was in all instances considerably greater than that lost in the visible "smoke." (ARB)


Unlike other cities, Los Angeles has an atmospheric problem mainly attributable to industrial fumes rather than to coal dust and smoke. The accumulation sometimes reduces visibility to less than a mile and is extremely irritating to the eyes and nasal passages. Stricter, more pointed legislation has been passed in an effort to correct this situation. (USPHS)


Comment is made on the nature and extent of grit and sulfur emission from collieries, coke ovens, gas works, boiler houses, iron and steel works, railways and locomotives, and electricity stations. Fuel supplies should be more uniform in their grading, and iron and steel works should be equipped with efficient dust-recovery devices fitted to the National Electricity Board is given. (APB)


Atmospheric pollution from industrial sources is divided into smoke, grit, or fly ash and sulfur oxide gases, and occurrence of these nuisances is surveyed under the headings electricity stations, gas works, and iron and steel works, and miscellaneous undertakings such as collieries, clay and brick works, etc. A more complete atmospheric pollution census, covering the whole country, would give material of value for the study of the extent of nuisances in specified industries and processes, the nature of such nuisances, their consequences, the difficulties standing in the way of their abatement, and the value of remedial measures already taken. (APB)

1948


The work done during 1948 by the Pittsburgh Bureau of Smoke Prevention is reviewed. The report covers all the stationary stacks within the city of Pittsburgh. A separate report covering railroad smoke conditions is issued.

Sulfur dioxide is suggested as the likely toxic agent at the Donora (Pa.) disaster, but it is not considered likely that Pittsburgh could have such a disaster because of the small amount of sulfur dioxide emitted there.
AIR POLLUTION—A BIBLIOGRAPHY

An analysis is given in percentages for substances collected throughout the Pittsburgh area during 1948. The highest concentrations of substances in the dust were sulfur trioxide, 18.9 percent; ferric oxide, 13.37 percent; silicon dioxide, 12.3 percent; and zine oxide, 7.5 percent. The only material considered pollen was lead oxide, which was only 0.003 percent of the total and therefore thought to be harmless. The sulfur trioxide represents all kinds of sulfur compounds, so that the percentage of gaseous sulfur compounds was much less. It is emphasized that all dust that falls in the area does not originate directly from combustion but much may be blown up from the ground.

Graphs are included, comparing results of dust collection in 1948 with those for 1938; a marked reduction is shown for the former. (USPHS)


The Lord President of the council was asked whether, in view of the disputes current between many local authorities and the electricity commissioners as to the harmful effect of unwashed sulfur smoke on areas near power stations and as to the best method of its abatement, he would instruct the Committee of Industrial and Scientific Research to investigate and report. He replied that measurements of sulfur pollution in the air are being made by the Department of Scientific and Industrial Research in many parts of the country, including areas near power stations, and some information is already available on the effect of sulfur on buildings and vegetation. The Department is already trying to find methods for removing sulfur from the flue gases of power stations that would prove less costly and troublesome than those in use at present. The problem is not an easy one, and a quick remedy cannot be expected. (FA)


Twenty-three papers, describing the physical and chemical properties of dusts, the methods of measuring the physiological effects, and the methods for controlling dust, are included. (APB)

1949


Among the known constituents of the gaseous phase of the principal smoke stream are carbon monoxide, carbon dioxide, hydrogen sulfide, and hydrogen cyanide. An attempt was made to determine these constituents accurately under conditions simulating those of normal smoking. The amount of carbon dioxide is less than 4.3 ml per cigarette. The amount of carbon dioxide is 7.7 percent by volume, equivalent to 34 ml per cigarette, and of hydrogen sulfide, 0.0019 percent by volume of the gaseous phase; hydrogen cyanide was not detected. Acetylene was found in the smoke, and other unsaturated hydrocarbons were indicated. (APB)


The first report appeared in 1948 and was reviewed in the Journal of Industrial Hygiene and Toxicology (vol. 31, 1949, p. 121). In this Institute showed that their smog index permitted reliable forecasting of normal conditions in the Los Angeles area.

The present report contains short sections on analysis of the air (for unusual gases and unusual particulate matter), factors affecting visibility and causing irritation of the eyes, the meteorologic mechanism of smog, the smog index, and smog forecasting.

According to the conclusions, further improvements of the use of the smog index permit current predictions of eye-irritating smog 84 percent of the time.

A specific etiologic agent has yet to be identified, but apparently a reasonable hypothesis can be reached by producing synthetic smokes in the 233 cubic-foot (about 10 m³) experimental chamber. Using the maximum values of various constituents found by air analyses on smog days, a mixture containing ammonia, formaldehyde, sulfur dioxide and trioxide, nitrogen oxides, and very small additions of acrolein. Hydrogen peroxide, an oil aerosol, and some carbon black in oil are being tested. None of these substances used in concentrations actually found in air (less than 0.6 lg in.) causes eye irritation due to smoke alone; together these substances definitely cause irritation.

The reviewer might point out that the causes of the dense Valley disaster in Belgium (1930) and the recent trouble at Donora, Pa. (1948), are still unknown. It seems likely that the reagents, and darkening of paint have been explained is that the cause was complex and that a considerable number of foreign substances were present under unusual meteorologic conditions for ill effects to be noted.

1950


An increase in petroleum production of about 50 percent during the past decade has intensified atmospheric-pollution problems in the vicinity of refineries. The development of catalytic cracking has increased the number and kind of volatile compounds escaping into the air. Sulfur-bearing compounds represent one of the major problems. These enter the atmosphere as hydrogen sulfide and organic compounds of sulfur dioxide. Crude oils contain many constituents, such as arsenic, phosphorus, silicon, vanadium, and lead, which may escape as volatile compounds formed during cracking processes. Sulfur compounds tend to concentrate in the high-boiling fractions during primary fractionation. These fractions are subjected to cracking operations.

Health hazards, nuisances, and darkening of paint have been attributed to compounds discharged from tanks during filling operations and from tank "breathing." Burning such compounds may help to reduce the hazard, provided excessive sulfur dioxide is not released. Removal of sulfur compounds in alkali scrubbers is a more positive control.

Sulfur compounds removed may be reclaimed by various methods. For example, hydrogen sulfide may be removed from petroleum gases by bubbling them through water with diethanolamine. The hydrogen sulfide is then stripped off by steam and converted to sulfuric acid or elemental sulfur. Alkaline materials such as tripotassium phosphate also may be used for scrubbing and the hydrogen sulfide stripped by heating. The scrubbing materials in these processes can be reused.

Disposal of waste-acid sludge presents a problem. Burning in open ponds releases considerable sulfur dioxide. Controlled burning with collection of contaminants is preferable.

Spills and leaks may contribute appreciably to air pollution. The need for proper maintenance of equipment is indicated. (PHEA)


Various gases found in the atmosphere are discussed, including the sulfur gases and vapors, nitrogen compounds, halogenated materials, carbon dioxide and monoxide, exhaust gases, peroxides, and ozone. The sulfur gases and vapors are tested in more detail, including physiological effects and a summary of the various ways to remove sulfur compounds from waste gases.
number of constituents in contaminated atmosphere is as yet unknown. Although methods of analysis have been devised for the common gases from industrial pollutions and their prevalence is recognized generally, there are many organic vapors and compounds that may exist at concentrations above those for threshold physiological effects. (PHEA)

1951


Artificial smogs have been found useful in verifying the accuracy of current knowledge of the composition of natural smogs. The preparation of atmospheres containing gases and additives is in general relatively simple, but the preparation of atmospheres containing dispersed liquids and solids is much more difficult. Techniques for preparing such atmospheres on a continuous basis are described.

Aerosol generators were developed, which disperse liquids by an aspirating action and can also be used for dispersing certain solids. In a device for continuously dispersing powders at a uniform and easily controllable rate the powder is spread on a long brass trough that is drawn beneath an air-operated glass aspirator. Chambers in which the atmospheres are blended and tested are described.

The methods and equipment developed have been very useful in air-pollution studies and should be useful in many more studies of dispersions in air. (PHEA)


The concentrations of volatile sulfur compounds in the air of various American cities, including St. Louis, during the winter of 1936-37 have been reported earlier. The observations described in the present paper were made so that the sulfur concentrations could be compared with the degree of pollution found 14 years earlier.

The method of estimation was by absorption in sodium hydroxide and titration with iodine. All sulfur compounds and other reducing agents that are absorbed by 0.1N sodium hydroxide and oxidized by iodine are expressed as sulfur dioxide, but it is believed that such substances other than sulfur dioxide are present in small quantities and have been so reported in this paper.

The concentrations found in the winter of 1930 were 83 percent lower and those found in the summer 73 percent lower than those of 1938-39. The reductions are probably due in part to the application of the smoke-regulation ordinance and in part to the increased use of oil and gas in place of coal.

The higher average concentrations were found downtown, and the downtown concentrations of 1950 were comparable with those found 1 to 20 miles outside the city 14 years earlier.

It is estimated that space heating contributes little more than a quarter of the total winter pollution. The remainder comes from industrial plants, automobiles, trucks, buses, water heating, refuse burning, and locomotives. The average concentrations in summer and winter in 1950 were 0.630 and 0.041 p. p. m., respectively. (BII)

CHEMISTRY

1883


The report of the committee, issued in 1883, is the outcome of the work of a committee formed in 1881 to determine means for checking the growing smoke evils attending the combustion of bituminous coal.

A previous effort of attention seems to have been centered chiefly on smoke from factory and other furnaces, but in the present movement the importance of the domestic fireplace has been generally recognized as a foe, if not the chief foe, to the purity of the air of cities.

Methods used to examine chimney gases given off by stoves and grates are detailed. The chemical section of the report is said to be one of the most important contributions ever made to the knowledge of the combustion of fuel.

1913


Even when present in the air in excessive amounts, carbon dioxide exists in far too small quantity to act in any way as a direct poison. "Normally, the carbon dioxide in the lungs is 100 times as great as that in the atmosphere." (USPHS)

1929


Analyses are given of soot from two general classes of fuel-consuming installations—domestic installations and boiler plants. Soot from domestic installations is characterized by the large amount of combustible matter (carbon, hydrogen, and tar) that it contains and by the small amount of ash. Soot from the boiler installations is low in combustible matter and high in ash. Domestic soot, which usually contains 30 to 40 times as much tar as boiler soot, is more injurious and, in addition, is produced in at least 12 times the quantity from the same amount of coal.

Briefly stated, soot consists of finely divided carbon, tar, ash, ammonia, sulfur acids (sulfurous acid, sulfuric acid, and hydrogen sulfide), sulfur dioxide, and sulfur trioxide. It contains poisonous organic compounds while ash, comprising the mineral matter found in coal, is said to cause little injury.

1925


Tests were carried out on motor vehicles to determine the percentage of carbon monoxide in their exhaust gases and to gain information relative to ventilations of the Hudson River tunnel, the South Hills tunnel in Pittsburgh, and a vehicular tunnel in Boston. The report deals only with poisonous effects of carbon monoxide, with no reference to other toxic gases. (CLAC/ UCLA)

1925


The work of a smoke inspector is closely allied to chemistry, as it constantly involves a definite field of combustion chemistry.

The history of chemistry is summarized briefly.

1928


Henderson's standards of carbon monoxide, in which an index is obtained by multiplying the hours of exposure by the parts of CO per 10,000 parts of air, are adopted. An index figure of 6 gives just perceptible effects; of 9 gives headache and nausea; of 15 is dan-
A concentration of 4 parts per 10,000 is regarded as "decidedly inimical to health"; a concentration of 2 parts is the Chicago limit.

The investigations gave the following results:

<table>
<thead>
<tr>
<th>Tests</th>
<th>CO parts per 10,000</th>
<th>Average</th>
<th>Maximum</th>
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<tbody>
<tr>
<td>23 in 14 cities, at congested traffic centers</td>
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<tr>
<td>102 in 37 repair garages, naturally ventilated</td>
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<tr>
<td>7 in 6 motor buses, heated by exhaust-driven</td>
<td></td>
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<tr>
<td>DJE</td>
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</table>

These suggest that danger is likely to exist only in garages, where car engines are run during testing in confined spaces. The very practical, simple suggestion is made that in such circumstances a flexible hose should be fixed over the end of the exhaust pipe to convey the exhaust gases outside at some higher level. As compared with a control, this was found to reduce the CO from 2.0 to 0.7 parts.

That traffic police at busy centers, where many cars discharge gases while standing, may suffer from continuous exposure to small doses for long periods is shown by the blood of one showing as much as 30 percent of carbon monoxide saturation of hemoglobin.

Estimations of CO were made by the iodine pentoxide method; other substances were frozen out by liquid air at 190° C. (III)

1932


Too little attention is given to the pollution of the air by motor exhaust fumes. Estimates of gallons of fuel used for the years 1911, 1912, 1931 show a marked increase. Carbon monoxide is regarded as the most important constituent contaminating the air. It constitutes 6.5 percent of the total exhaust gas, 72.8 cu. ft. being produced per hour with a car running 20 miles per hour. Reporting on various investigators' determinations of carbon monoxide in cities, which ranged from 3.4 to 17 parts per 100,000, Keesen, Froebese, and Turman state that in their investigation the concentrations rarely exceeded 20 parts per 100,000 and hence there is "no danger of acute carbon monoxide poisoning of ordinary street users." Traffic police are considered to be stationed in a more hazardous position, with as much as 30 percent carbon saturation of hemoglobin being reported at the end of tours of duty. It was found that exhaust condensates cause lung injury in mice, but it is believed that these products do not exist in high enough concentration in the street to cause injury. (USPHS)

1936


Although the belief is widespread that dangerous concentrations of carbon monoxide are often present in buses and on the streets where they operate, this idea is erroneous, according to the findings of the engineering department of the New York Transit Commission. In all the time buses have been running, no case fatality has been reported as due to carbon monoxide. The offensive aldehydes give rise to complaints of bus fumes. The highest concentration of carbon monoxide found on a bus was 2 parts per 10,000, and this was found while the bus was standing. (USPHS)

1937


Exhaust gases were collected in a special apparatus and analyzed. Products differing widely in nature were isolated, for example, acidic compounds, neutral cracked compounds, and other substances probably of an aldehydic nature that resinate at low temperatures.

(USPHS/CLAC/UCLA)


Research on the subject of gassing by motor buses was carried on jointly by the Texas Co., the Standard Oil Co. of New Jersey, and the Capital Transit Co. The object of the tests was to ascertain what engine operating conditions produced maximum fuming, to develop a technique for analyzing these exhaust gases, and to determine what fuel characteristics were influential in this regard.

It was found that the fuel condition created in decelerating was responsible for the greatest amount of objectionable odors. Several types of degassing valves were tried; the type that proved most satisfactory was one that breaks both the intake vacuum and the ignition when decelerating. Aldehyde content was found to be about 40 times greater in the exhaust during deceleration than during acceleration or under normal run. It is not contended that aldehydes are responsible for all the exhaust odors, but it is contended that they are largely responsible and can be measured. Fuel characteristics were also found to influence aldehyde content and consequently contributed to odor nuisance. The aldehyde content of all types of fuels tried decreased as the volatility increased. Volatility was therefore considered to be a prime factor in exhaust odor, as measured by aldehyde content.

Carburetor adjustments to the manufacturer's original specifications and the installation of high-temperature intake manifolds also resulted in great reductions in odor and aldehyde emission. A total reduction of some 94 percent in odor and fuming was noted by incorporation of these combined methods of adjustment and the use of fuels of higher volatility.

It was concluded that aldehydes produce at least a major part of exhaust odors and that the correction of no single item will solve the problem. A complete program for the elimination of exhaust odors includes engine, carburetor, and ignition maintenance, use of proper degassing valves, selection of proper fuels, and, possibly, use of high-temperature intake manifolds.

(USPHS/CLAC/UCLA)
CO content in diesel exhaust gases is very low. The amount of smoke and its odor are less at full load than under part load. Unburned solids and liquids, in the form of lubricating oil, organic acids, aldehydes, and oxides of sulfur, are always present in the exhaust. Purification by means of a water bath and cyclone-type separator in a series can eliminate 70 percent of the solids and liquids, the other 21 percent being removed with an activated carbon filter. Addition of Na₂CO₃ or Ca(OH)₂ to the water bath is recommended. (CLAC/UCLA)


A report of results of automotive laboratory studies regarding exhaust gas odors. The committee reports that exhaust-gas odors can be materially reduced through proper maintenance, correct fuel volatility, use of degassing valves, and increase of manifold temperatures.

A standard procedure also is suggested for chemical tests for aldehydes as a measure of exhaust odors. The procedure is that used by the New York Publications Service Co. and is essentially that adopted by most investigators. The gas sample is collected in water and the aldehyde concentration estimated colorimetrically. (CLAC/UCLA)


Economy in operation and efficiency in firing are results of a basic knowledge of the mechanics of oil combustion and constant application of this information to boiler operations in oil-fired installations. What happens in burning fuel oil and the theory of this oil burning are considered. Two opposing reactions begin after the initial gasification and formation of the elementary hydrocarbons. One is hydroxylation, with the formation of aldehydes and eventually formaldehyde; and the other is thermal decomposition, with the formation of soot. Experimentation has shown that an initial action of the hydrocarbon with oxygen occurs preliminary to final combustion, forming an intermediate unstable hydroxylated compound, aldehydes, before burning to CO, CO₂, and H₂O. In the hydroxylation reaction alcohol is formed first, which then reacts with more oxygen to form aldehydes and formaldehyde. Depending upon the amount of oxygen present and the temperature, the formaldehyde can further react in three different ways to form combustible gases or pass off unreacted if cooled to a low temperature before combustion is completed and equilibrium established.

Combustion of oil requires turbulence, temperature, and time. A variation in one must be counteracted by an adjustment in one or both of the others. Also, the fuel-oil mixture must be in the correct ratio; incomplete mixing of the air and fuel oil will produce a long, lazy flame that gives off little heat and much free carbon.

An outline of the general process of burning has been made in the hope that the handling of these factors will serve as a guide to improvement in operation. (CLAC/UCLA)

1949


A very useful compilation in syllabus form. Each item is in itself a brief abstract. (JHIT)

1949


Toxic gases in diesel engines are nitrogen oxides, CO, CO₂, and SO₂. The ratio of nitrogen oxides to CO may be as high as 5:1. An engine in good condition produces 0.267, 0.001512, and 0.000532 c. f. m. per locomotive hp. of CO₂, nitrogen oxides, and CO, respectively. (CLAC/UCLA)

1943


The disagreeable odors from exhaust gases of bus engines are produced during deceleration, with closed throttle and engaged clutch. Evidence indicates that these odors, reminiscent of aldehydes, are the result of incomplete combustion.

To obtain data for this report two test engines were used, a 6-cylinder, L-head bus engine and a CFR engine. Each was coupled to a d-c. dynamometer to provide drive simulating road conditions of acceleration, constant speed, and deceleration. The sampling of exhaust gas were taken in a specially built apparatus, which was used in the tests for odor rating and aldehyde content. The odor-rating test seemed quite arbitrary in that it depended upon personal sensations, which are not nearly reliable. Chemical analysis, however, showed that formalddehyde was always a constituent when the exhaust gases gave off the pungent odor.

Chemical analysis for aldehydes was carried out, using the reaction with Schiff's reagent; the intensity of the reaction color, which is related to aldehyde content, was measured by means of a Yoe photoelectric colorimeter.

At constant speed and partly closed throttle operation it was found that aldehyde content and odor intensity were high at low air-fuel ratios, increasing as the ratio of air to fuel was increased; the gases caused irritation to the eyes and nose.

As field observations show that most objectionable odors are noticeable during deceleration, a series of deceleration tests was carried out. With excessive residual gas dilution, as is the case under high speed and closed-throttle operation, conditions for combustion are extremely adverse, causing the formation of odor and aldehydes. The quantity of aldehydes in the exhaust gases depends upon the completeness of combustion in the cylinder.

Fuel volatility and manifolding also were found to play an important part in odor and aldehyde formation. The more volatile fuel forms less aldehydes under normal operations but is more likely to form aldehydes during deceleration owing to excess fuel clamping to manifold walls and furnishing an enriched charge to the cylinders; this tends to increase aldehyde formation.

Among methods suggested to remedy the situation are the use of high-volatile fuel, increase in the intake-mixture temperature, installment of high-temperature manifolds, removal of deposits from the inside of manifolds, low adjustment of the idling mixture, and a mechanical device to cut off fuel or ignition during deceleration.

Several interesting graphs and tables are included. They show the results of the various tests and are quite significant in portraying the findings of the investigators. (CLAC/UCLA)


The combustion process in diesel engines is characterized by two processes that progress side by side: (1) Direct oxidation of the fuel through a series of
reactions, in which intermediate partly oxidized compounds are formed, and (2) thermal decomposition of the fuel, as caused by combustion or the destruction of products. Chilling of the direct-oxidation reactions will result in carbon monoxide and aldehydes in the exhaust. Carbon monoxide is an intermediate product in the direct oxidation of hydrocarbons and is also a final product of combustion under over rich conditions, but aldehydes are formed only in direct oxidation.

The formation of carbon monoxide and aldehydes from incomplete oxidation are conditioned by: (1) The extent to which locally overlean regions are formed, (2) the extent of chilling of regions in which direct oxidation reactions occur, (3) the concentration of fuel, (4) the variables affecting reaction velocity and mechanism, and (5) the time available for reaction. (CLAC/UCLA)

1946


Exhaust gases from internal-combustion engines can be purified by passage through an oxidation mixture containing equal parts of KClO3, MnO2, Fe oxide, CaO, and CaC, which converts CO to CO2, followed by passage through an absorption mixture containing 50 percent of CaO, 20 percent of Fe sulfate, and 30 percent of NaOH. Suitable baffling and metal webbing remove solid particles. (CLAC/UCLA)


The first step in low-temperature hydrocarbon combustion is the formation of peroxides. Modes of decomposition of tertiary, secondary, and primary alky1 hydroperoxides are formulated. Most of the hydrocarbon molecules undergo the first step of oxidation by reaction with a free radical, complete combustion being a composite process consisting of several chain reactions following each other, with molecular products in between. The initial product of oxidation is an alkyl hydroperoxide formed at a tertiary carbon atom. This product then may undergo dehydration to an aldehyde, the dehydration being a surface reaction. The resulting radical RCHO is known to be unstable, readily recombining to give formaldehyde (CH2O)2. The split occurs at the C-C bond (not at the C-H bond) in agreement with the weaker strength of the C-C bonding.

These radical decomposition modes of alkyl hydroperoxides exist in the polymerization of styrene in the presence of oxygen the only important oxidation products that appear are benzaldehyde and formaldehyde in equilibrium quantities. Small amounts of oxygen can cause a catalytic cracking of large amounts of acetaldehyde, and the great propensity—if not exclusive formation—of formaldehyde, compared with the higher aldehydes, has been noted in the oxidations studied.

In the case of iso-octane the formation occurs a degradation to aceton, formaldehyde, and water via a series of intermediate peroxides. Aldehydes other than formaldehyde only appear under conditions favoring surface access, which is not possible in engines. Finally, excited formaldehyde and carbon monoxide are formed, the product of which is compatible with the above degradation scheme. (CLAC/UCLA)

1947


Exhaust gases are rendered nontoxic by passing them over a supporting metal resistant to oxidation at a high temperature, the surface of which is activated by a precious metal such as Pd. The support may be made of a special steel such as “Sicramal” or “Nicrotherm.” (CLAC/UCLA)

657. MCEWEN, LLOYD H. Exhaust Gases—Their Relation to Atmospheric Pollution. Office of Air Pollution Control, County of Los Angeles, Calif., and Engineering Dept., University of California, Los Angeles, 1947, 57 pp. (“Ditto” copy.)

A study was made of the literature to ascertain to what extent the exhaust gases from internal-combustion engines contribute pollutants to the general atmosphere. Records of work done on exhaust gases of both gasoline (spark ignition) and diesel (compression ignition) engines were covered.

It was found that many capable investigators proved that aldehydes, especially formaldehyde, are emitted as one of the constituents of the exhaust gases from internal-combustion engines. Most authorities believe that there is no excuse for smoke or odoriferous exhausts from either gasoline or diesel engines. When bus and truck fleets are kept in good mechanical condition and are operated properly, their exhausts do not pollute the atmosphere.

Included with the paper are three appendices. One outlines a bibliography of 50 articles referred to in the text; the second includes abstracts of the 80 references; and the third lists 21 articles read but not considered pertinent to the subject.


The main source of air pollution is the burning of coal. Additional sources are certain chemical and metallurgical industries. Results of an investigation of the distribution of pollution in a city and its environments at Leicester are discussed. The role of the chemist in the study of pollution has been to devise methods of measurement, to investigate the problems of the absorption of gases by physical and chemical methods, to endeavor to prevent pollution, and to provide a valuable byproduct and eliminate waste. (FA)


An account is given of the gaseous and solid impurities existing in the atmosphere and the methods that have been employed for their removal. The role of the chemist in the study of pollution is to devise methods of measurement, to investigate the problems of the absorption of gases by physical and chemical methods, and to attempt not only to reduce pollution but to produce valuable byproducts and eliminate waste. (FA)


The circumstances, type of design, and operating factors that will help to eliminate smoky exhaust from diesel engines are considered. Diesel exhaust smoke results from apparently contradictory causes. Such causes are too early or too late injection, too low or too high cetane number, too low or too high compression, or too heavy or too light a load.

The discoloration of exhaust gas is caused by liquid or solid particles in the gas. Exhaust smoke is always the product of combustion that is still in progress when the gas leaves the engine cylinder. Therefore, there is only one cause for exhaust smoke— incomplete combustion. Two types of smoke are prevalent, "hot smoke" resulting from sluggish burning of the fuel and "cold smoke" resulting from fuel particles that have not been ignited or those that were ignited too late. The latter type of smoke is usually accompanied by an acid odor characteristic of diesel exhausts. Exhaust smoke, showing incomplete combustion, may be the product of misfire or late burning. Misfire will
produce cold smoke, while late burning will produce hot smoke. Such factors as sluggish combustion, late ignition, mixture irregularity, atomization, spray distribution, turbulence, and ignition lag are fully discussed. The results of tests are presented in graphs and tables showing clearly the effects of the various influencing factors. Also noted are the effects of cetane number and fuel volatility.

The latter part of the report deals with smoke diagnosis and with possible means of smoke elimination. What the diesel needs, both for stable running and for nonsmoking, is an injection pump with declining delivery characteristics.

Smoke measurements are made with a standardized type of smoke meter known as the CRC Photovolt smoke meter. A complete description of this smoke meter is given along with its schematic diagram and an outline of its operation. Equations for calculating smoke density are presented. It is stated that the CRC smoke meter will give results reproducible within 10 percent. (CLAC/UCLA)

1948


The chemical nature, sources, and physical properties of nuclei in relation to atmospheric pollution are discussed. The far greater influence of condensation nuclei than of dust is emphasized. (FA)

1949


The chemistry of smog, the sources of atmospheric contamination, the formation of contaminants, and the interrelationship of the contaminants after they are disseminated into the air are discussed.

Virtually every process as an operation that produces gas or fine particles is a potential source of atmospheric contaminants. Combustion of fuels, incinerators, industrial operations, traffic, building and highway construction, and windstorms are typical examples. In making an analysis of the raw material, which is considered the primary source of atmospheric contaminants, the composition of the material must be determined, as impurities, even if present in very small amounts, can be significant if large quantities of material are processed. Another important step in the evaluation of atmospheric contamination is the study of the chemical reaction that takes place when the raw material is processed. Combustion of coal can be considered a simple example.

The chemistry of smog constituents, however, does not cease with their discharge into the atmosphere. The possibilities of oxidation of some constituents and the interaction of the numerous constituents that are usually present are almost unlimited. As an example, sulfur dioxide ($SO_2$) is mentioned. It is present in the air to some extent in most cities and probably has been more widely studied than any other single atmospheric contaminant, yet there is still considerable discussion regarding its action in the atmosphere. Evidently, the chemistry of smog is complex, but the answer to such questions is essential for evaluating the effect of atmospheric contaminants as nuisance and on health. (PAH)

1950


The word "smog" has come to refer to the sum of air contaminants, mostly smoke, and air pollution. The chemistry of smog is an essential factor in its evaluation and control. The sources, formation, and interrelationship of the contaminants are discussed, using combustion of coal and production of zinc as examples and showing that the reactions and interrelationships may be quite complex. A number of questions calling for increased study are raised. The Donora (Pa.) investigation furnished some experience in developing methods for answering these questions. The weather is an important factor in smog production. The five substances contributing most to the atmospheric load are: Total particulate matter, sulfur dioxide, total sulfur, carbon monoxide, and carbon dioxide. A number of others in smaller quantities contribute to the total effect. The toxicology of the single substances is fairly well known, but the physiological action of mixed gases and the influence of aerosols is an almost unexplored field. (IHD)

1951


Methods for identifying, examining, and controlling airborne particles are discussed, with particular reference to the chemically toxic materials used in atomic-energy production. A detailed bibliography is given. (APB)

1951


Gaseous-phase reactions in unpolluted air, which are permitted in the lower atmosphere, are discussed on the basis of photochemical principles. Photochemical reactions, which may occur in polluted atmospheres, are discussed. They include the photolysis and oxidation of sulfur dioxide and of aldehydes, ketones, hydrocarbons, and other organic compounds. In the oxidation processes it is shown that ozone may be expected as a byproduct. The role of nitrogen dioxide is stressed as a possible photosensitizer in the atmospheric oxidation of air pollution. (APB)


Air pollution in the Los Angeles area is characterized by a decrease in visibility, crop damage, eye irritation, objectionable odor, and rubber deterioration. These effects are attributed to the release of large quantities of hydrocarbons and nitrogen oxides to the atmosphere. The photochemical action of nitrogen oxides oxidizes the hydrocarbons and thereby forms ozone, responsible for rubber cracking. Under experimental conditions organic peroxides formed in the vapor-phase oxidation of hydrocarbons have been shown to cause eye irritation and crop damage resembling closely that observed on smog days. The aerosols formed in these oxidations contribute to the decrease in visibility. The odors produced by oxidation of gasoline fractions are similar to those associated with smog. Hydrocarbons in cracked petroleum products, harmless in themselves, are transformed in the atmosphere into compounds highly irritating to both plants and animals and should therefore be considered as potentially toxic materials. A proper evaluation of the contribution of air pollutants to the smog nuisance.

(A_pb)
must include not only the time and place of their emission but also their fate in the air. (Author’s summary) (17 refs.)


Investigations of Los Angeles smog by mass spectrometric analysis of cold-trap concentrates indicate that most of the irritant substances are composed of the products of reaction of unsaturated hydrocarbons with ozone and nitrogen dioxide. The concentration of these smog constituents is less than 0.5 p. p. m. by volume. Hydrogen sulfide was not observed, and sulfur dioxide was found in only one smog sample, and that in very small amount. The concentration of carbon monoxide is generally up to 0.0004 percent by volume and may rise to 10 times this value during heavy smog.

As little as 0.000001 p. p. m. of some smog constituents may be determined by the method described, and about 60 chemical compounds have been identified or tentatively identified. (AIHom)

1952


Transport, settlement, and rate of deposition of atmospheric dust due to gravity are discussed. Deposition due to interception and inertia; thermal and electrostatic deposition; sonic and ultrasonic coagulation of particles; and diffusion, coagulation, and adhesion of dust particles are described. (API)


Very little is known about the real heart of the problem, namely, the effects of air pollutants on the health of individuals living in urban environments. Toxicologic information is needed to answer the following questions: (1) What is the identity of the substances in the polluted atmosphere? (2) Under what conditions of exposure may such substances be injurious? (3) What is their effect on health? The discussion is divided into three parts: (1) Current information on the composition of the atmosphere of industrialized environments; (2) factors governing the fate of inhaled air contaminants (bodily intake, absorption, distribution, and excretion); and (3) the toxicity of certain chemical air contaminants. (36 refs. cited)

DUST, GASES, AND FUMES

1895


Careful experiments to determine the composition of the atmospheres that cease to support flames of various combustibles are described.

1903


Air in which gas is burned is more offensive than that to which a proportionate amount of CO has been added; the cause is sulfur. The average English gas contains 0.46 grm. per m.³. Sulfur is present usually nineteen-tents as H₂S, and one-tenth in other forms, such as CS₂. The sulfur in gas is largely responsible for the injury to the bindings of books.

Experiments were made with gas-combustion product in two rooms. The chief conclusions are: (1) The unpleasantness of air in gas-lighted rooms is due to the presence of sulfur in the gas, and varies with the amount of sulfur. (2) Gas purified of CS₂ (by purifier of CaSO₃ or other means) is greatly superior hygienically to gas only purified from H₂S.

1928

673. TYCHOSS-ROCHESTER. How Big Is a Hailstone? Vol. 18, 1928, p. 139.

Dust pervades every part of the atmosphere. It is not confined to just the air near the surface of the earth. It is found in the winds high above the mountain tops. As far up as man has penetrated he has yet to reach a stratum of atmosphere that is free of these minute particles.

1930


Since the early history of the use of coal (and later of oil) as fuel, protests and legislative action have been directed against the smoke nuisance. The complaints have been based upon waste of fuel (poor combustion), corrosive or toxic effects of the gases mixed with the smoke particles, cost of cleaning buildings and household materials, aggravation of fog and haze, and, more recently, interference with the visibility desired in aviation.

Although there is as yet no convincing proof of the harm done by breathing the smoke and soot particles contained in the air of our large industrial cities (concentrations of 0 to 3 mg. per m.³), the development of radiation therapy gives an effective hygienic argument against smoke—it filters out a substantial portion of solar ultraviolet radiation.

Methods of determining and controlling the emission of smoke and legal measures in force in England, France, and the United States are discussed briefly. (15 refs. cited)

1940


1. An apparatus has been devised, using two thermal precipitators, for measuring the percentage number of siliceous dust particles of different size ranges removed from dust-laden air by breathing.

2. It has been found that about 25 percent of particles of size 0.2 μ and about 80 percent of size 2 μ are removed. Between these two sizes the percentage removal is nearly proportional to the square root of the size.

3. Above a size of about 3 μ the percentage removal increases slowly until at a size of 6 μ about 95 percent of the particles are removed.

4. It has not proved possible to explain the square-root relationship found between size and percentage removal, theoretically, but the calculated displacements due to a combination of sedimentation and Brownian motion appear to be quite adequate to account for the removal of the particles.

5. It appears likely that the larger particles will tend to be deposited in the larger air passages and with decrease of size there will be a tendency for the particles to be deposited in smaller air passages. Owing to the subsequent expulsion of particles from the larger air passages by physiological mechanisms, the size distribution of the dust in the inhaled air may be some guide to the size distribution of the dust ultimately retained by the lungs. (JHIT)

Describes methods of oxide recovery from secondary smelter stacks. The removal of the oxides eliminates a definite health hazard, which may vary in degree depending upon the kind of oxide that is discharged to the atmosphere.

Unlike recovery of dust from many other industries, the recovery of metallic oxides offers considerable gain. In some instances oxide recovery equipment pays for itself in 6 months or 2 years, depending upon the kind of oxide that is recovered.


Pathogenic organisms behave with respect to suspension, dispersion, and transportation in the air and in the respiratory tract like any other particulate matter. Particulate matter is dispersed in two ways, dynamic projection and air carriage. In a sneeze or cough some droplets are projected by a dynamic projection and travel certain distances in the air. If a droplet as large as 1.6 mm is projected at 152 ft. s. at breathing height of man, then the droplet will reach the floor in an approximate distance of 15 feet. If the droplet is less than 0.1 mm., it is not projected any appreciable distance, and must depend on air movement for dispersion. No general law can be said to govern the velocity and direction of spread of particulate matter and it can only be said that enough air movement exists to insure positive dispersion of the particulate matter.

The respiratory tract, among other functions, serves to free inspired air from harmful concentrations of inspired dust. Its efficiency is close to 100 percent for particles of 5 microns and larger, and goes down to 20 percent for particles of less than 0.3 micron. An aggregation of particles acts as a unit, and hence the efficiency of dust removed in the respiratory tract increases with the degree of flocculation of the inspired material. Infection cannot gain entrance to the deep lung tissue by way of the respiratory tract unless the particle size of the causative agent is below a certain maximum diameter, which permits it to penetrate to the alveoli (except for the possibility of absorption through the upper respiratory tract). The average diameter of the willemite particles, measured at a magnification of 1,125 under an oil-immersion objective, usually approximated 0.5 micron. The particles suspended in air readily passed through a layer of water in washing flask. They were promptly coated and agglutinated by the saline aerosol, the mean micellar (droplet) diameter of which was below 0.5 micron (at a magnification of 1,125).

Groups of rabbits in one series were exposed in a chamber, usually for 5 hours, to an atmosphere of fine willemite dust mixed with an organic dust, while comparable groups of rabbits in another series were exposed simultaneously in a similar chamber to the same amount of dust mixed with saline aerosol instead of air. In both series, dust tended to accumulate at bifurcations of the bronchi and alveolar ducts, along surfaces facing the inspiratory current, and in the alveoli, particularly near the hilus and adjacent subpleural zones. However, the amount of dust deposited in the lungs appeared much less in the series of rabbits exposed to particles treated with saline aerosol. Likewise, the dust deposits, particularly in the bronchi, disappeared after a shorter rest period in the groups exposed to the aerosol-treated dust.

Results of chronic experiments on rabbits and rats using aerosols of 5 to 10 percent sodium chloride solution alone and mixed with fine silica dust will be reported later. (Authors' summary) (10 refs. cited)


Gives results of a survey conducted to determine the concentration and nature of dust suspended in the air of New York. Dust counts were made by the standard light-field impinger technique and with the Owens' jet dust counter employing a dark-field oil-immersion optical system. Results of the dust counts made together with particle-size studies and gravimetric analysis are presented. (FA)


Wedgwood's new pottery near Barlaston, Staffordshire, is described. It has been in operation since October 1940. Photographs are included as well as diagrams of the Buell type K 11 "Micro-Lector" dust extractor in use at the pottery. (FA)


The finer dust particles suspended in the inspired atmosphere are considered to be a greater health hazard than large particles and are much more difficult to control. In previous papers, evidence was presented that aerosols of water or saline solution may be used to reduce such fine dust particles in the atmosphere by coating and agglutinating them; they also lessened the amount of dust deposited in the lungs. In the experiments described in this paper aerosols of 5 to 10 percent sodium chloride solution were used, the agglutinating property of which is greater than that of water aerosols. This increases the relative size of the aggregates of dust and should make the dust less likely to return to suspension in the air after settling.

In these experiments, a suspension in air was used in varying concentrations of fine willemite dust because even minute particles of this mineral are readily recognized in microincinerated sections of the lungs by their brilliant green fluorescence under ultraviolet rays. The mean diameter of the willemite particles, measured at a magnification of 1,125 under an oil-immersion objective, usually approximated 0.5 micron. The particles suspended in air readily passed through a layer of water in a washing flask. They were promptly coated and agglutinated by the saline aerosol, the mean micellar (droplet) diameter of which was below 0.5 micron (at a magnification of 1,125).

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Results of chronic experiments on rabbits and rats using aerosols of 5 to 10 percent sodium chloride solution alone and mixed with fine silica dust will be reported later. (Authors' summary) (10 refs. cited)


Proposals to extend the range of gases and fumes included in the list of "noxious and offensive gases" that are controlled by the provision of the Alkali, etc., Works Regulations Act, 1906, are being considered by the Minister of Health. A draft order (Draft Statutory Instrument, 1949; Draft of the Alkali, etc., Works Order, 1949,
proposed to be made by the Minister of Health under Section 4 of the Public Health (Smoke Abatement) Act, 1950, has been prepared adding that organic sulfur compounds, fumes containing carbioxide particles from black production works, and fluorine to the list. The order also adds black production works, fluorine works, and acid sludge works to the list of scheduled works. The intention underlies the range of processes carried out in sulfuric-acid works, bisulphite works, and cement-production works, which will render the works liable for registration under the act.

The draft order is being circulated to local authorities, manufacturers' associations, and various firms concerned with a request that any observations should be submitted to the Ministry before July 23. A public inquiry will be held before the order is confirmed.

1959


During the 1949 operating season, the Bureau of Industrial Hygiene of the Baltimore City Health Department studied seven Baltimore plants that manufacture asphalt paving materials. The purpose of the study was to evaluate the effectiveness of dust-suppression methods installed at the beginning of the year when an accelerated production schedule was instituted. The extent of the contamination of the atmosphere found outside the seven paving plants under study is unlikely to be detrimental to health, but it may cause discomfort. The nuisance character of the finely dispersed material results largely in property damage and irritation neighbors. The degree of the nuisance and attending complaints is dependent upon: (1) Efficiency of the dust-collecting equipment. (2) Population density of the neighborhood surrounding the plant (high, medium, and sparse classification). (3) Physical properties of the materials processed. These factors, together with the cost of dust collection, were evaluated.

To avoid repetition of the prevalence of complaints from handling finely divided materials, those plants in areas of high population density should install a commercial wet-type dust collector, and even the plants in areas of medium population density should consider installation of such equipment.


The peculiar conditions regarding dispersal of smelter smoke at Trail are outlined, and the development of the various sulfur-recovery processes employed is traced, with mention of the technical and economic considerations involved. The Trail smelter is located in a mountainous area where topographical and meteorological conditions are unfavorable for adequate dispersion of the sulfur dioxide contained in metallurgical waste gases. Expansion of the smelter output in the middle 1920's resulted in some atmospheric pollution, and proximity to the United States border lent international complications. Many of the developments were based on integration of new plants with existing ones and utilization of byproduct materials from established operations. The availability of ammonia made possible its employment as an absorbent for sulfur dioxide. The acidification process for releasing sulfur dioxide from the absorbing solution was practical because a supply of sulfuric acid was at hand and the company was already producing and marketing ammonium sulfate. Byproduct oxygen made it possible to operate the sulfur-reduction process. The availability of byproduct oxygen and substantially pure sulfur dioxide made it possible to develop the cyclic process of sulfuric acid manufacture. The 15 years before 1943 witnessed the development of processes and installation of fertilizer plants at Trail, with the result that sulfur dioxide has changed from a waste material to a valuable raw material in short supply. To meet the demand for acid for fertilizer production, roasting of iron concentrates for acid recovery became necessary in 1943. At present all roaster and sintering-plant gas is treated for sulfur recovery, and iron concentrate is roasted intermittently, depending on the demand for acid and the availability of custom zinc concentrates. Total current loss to the atmosphere from Trail operations is less than 9 percent of the sulfur charged. The sulfur released to the atmosphere annually in 1947 and 1948 was less than in any other year since 1944. (Author's summary)


A plausible assumption concerning the mechanism of entrainment of air by the jet leads to simple expressions for the mean temperature and mean velocity of a jet of hot air rising in a calm atmosphere of uniform potential temperature. The theoretical expressions agree with the laboratory measurements of Schmidt. The coefficient of diffusion for these conditions is of the same order of magnitude as that derived from the large-scale spread of cold smoke plumes. An approximate solution is given for the shape of the plume from a hot source in a horizontal wind. The reduction of maximum concentration at ground level, caused by adding heat to the effluent from a stack, is directly proportional to the strength of the heat source and inversely proportional to the height of the chimney and the cube of the horizontal wind speed. (PHH)

1951


In one step of the manufacture of titanium dioxide pigment, large quantities of acidic gases are released in a very short period. These gases contain sulfuric acid mist and droplets, some sulfuric trioxide and dioxide, and large quantities of steam. A Schutte-Koerting jet scrubber was installed to scrub the sulfuric acid constituents from the stack gases, the peak scrubber operation being timed to the period of maximum gas evolution. The water-scrubbed medium is neutralized to prevent corrosion and the creation of a water-pollution problem. The equipment, with proper operational and maintenance precautions, has operated satisfactorily, resulting in an effluent consisting of saturated air with no amounts of acidic constituents and a recirculation of acid mist or acid-wetted ore particles. (AIHOM)


Evaluation of dustfall measurements through scientific analyses is considered from standpoint of protecting industrial plants against claims and to aid in overcoming nuisances.

1956


In 1956 and 1957 the Air Hygiene Foundation of America, Inc. (now the Industrial Hygiene Foundation) published a very comprehensive report of the concentration of volatile sulfur compounds in several cities, including St. Louis. The purpose of the 1950 survey was to determine the existing concentrations and compare them with the concentrations encountered in the 1936-37 survey. It was desired to determine what results have been achieved in the atmosphere smoke-regulation program, to learn more about how meteorological factors affect volatile sulfur compound concentrations, and to obtain some estimate of the relative contributions of residential, industrial, and auto-
motive sources to volatile sulfur compound concentrations in the city.

The average reduction in the sulfur dioxide content of the St. Louis atmosphere from 1936–37 to 1950 was 73 percent in the summer and 53 percent in the winter. The factors probably contributing to this reduction were the use of low-volatile coal in hand-fired heating plants; washing of solid stoker boilers; change-over from coal to oil or gas; and dieselization of railroad locomotives. (4 refs. cited)


The relatively little known but increasingly important metal called germanium has been experimentally recovered from deposits of smoke stacks in England by the research laboratories of General Electric Co. Its growing importance is due to its use in electronics.

It has been known for 20 years that some of the coal fired in English factories contains germanium. When coal is burned in industrial plants some two-thirds of the germanium in it is expelled as a germanium sulfide or oxide. These compounds form a deposit in the flues. It is from these deposits that the germanium is recovered.

Fine dusts from gas works may contain 0.5 to 1 percent germanium. In the recovery process the compounds in which it exists are converted to germanium tetrachloride by treatment with hydrochloric acid. By further chemical processes, the tetrachloride is purified and the germanium obtained. Processes have now been developed that produce an economical yield. Supplies of high-purity germanium metal and germanium oxide are now available in England without imports.

It has been estimated that if only 100,000,000 tons of coal used in England each year contains germanium in the proportions found in samples from various coal fields, about 2,000 tons could be recovered each year as a byproduct of coal combustion.

Although there are many important uses of germanium, one of its newest applications is due to its being a semiconductor of electricity. It is now being used as a rectifier to convert alternating current to direct current. Some day it may replace some of the vacuum tubes for the purpose in radio equipment.

1958


Rainfall collections at six points were analyzed to measure the periodic washdowns of fluorine from the atmosphere in relation to the locations of operations that emit fluoric effluents, and charges of Spanish moss were exposed to measure progressive intake of fluorine from the atmosphere. Longer intervals between rainfall caused higher concentrations of fluorine at the several locations. Proximities of samples to sources of emissions were reflected by higher concentrations of fluorine in rain waters. These two feasible and economical procedures can be implemented in parallel to establish whether a particular locale is subject to atmospheric pollution and the degree of pollution. (APB)

METEOROLOGY

1906


Consideration of this inquiry has an important bearing on the practical question of the abatement of coal smoke. Dispensing with coal smoke is physically possible. If there are to be fogs anyway, it is the opinion of some that the effort to keep them clean is not worth the trouble and expense.

In a meteorological investigation made in the winter of 1902–3, 24 instances of fog were assigned to the effect of radiation, 3 to a change of weather in which warm air slowly passed over the surface that had been previously chilled, and 4 to the clouds forming above the surface; 8 were considered as consisting practically of smoke and nothing else. The author concludes that it is scarcely to be hoped that freedom from smoke will give immunity from fogs due to radiation.

If the figures for the winter of 1902–3 can be accepted as a guide, the Smoke Abatement Society has to deal with approximately 20 percent of the London fogs, the remainder depending upon uncontrollable physical processes. In addition to eliminating 20 percent of the fogs, the abolition of coal smoke would add most materially to the power of the sun to dissipate fogs and thus indirectly reduce their duration. Abolishing dirt and restoring daylight would be incidental advantages worthy of consideration.

1913


The effect of smoke and other impurities in the atmosphere of large cities on the meteorological conditions is discussed. The meteorological effects vary with geographical position and with the season of the year. Numerous tables are included summarizing observational data regarding the relation of smoke to atmospheric transparency, intensity of daylight, and temperature. (36 refs. cited)

1914


The condensation of moisture in the atmosphere—the initial step in the formation of clouds, fog, rain, snow—and has been explained for more than a generation by the presence in the air of myriads of minute (mostly ultramicroscopic) “dust” particles, each of which was supposed to serve as a center of condensation. The well-known instrument invented by Aitken in 1888, in which, after a small measured volume of air has been cooled by expansion, the resulting droplets of water are inspected through a microscope and counted, is known as the “dust counter,” because it has been assumed that the condensation formed in this process represents the number of particles of “dust” in the given volume of air. This idea is entrenched in the very latest works on meteorology in the English language, although qualified by the admission that in a highly supersaturated atmosphere such as may be produced at will in laboratory but hardly occurs in nature, condensation also occurs on ions, in the absence of “dust.” However, if we turn to recent German meteorological literature (for example, Wegerer’s Thermodynamik der Atmosphäre or the third edition of Hann’s Lehrbuch der Meteorologie, now appearing in parts) we find that a new idea, after slowly taking shape in the scientific journals for several years, has now definitely crystallized into the belief that “dust,” in any ordinary sense of the term, has comparatively little to do with condensation in the atmosphere. Yet, it is still believed that the water drop forms around a something-or-other that is not water. Ignorance as to what this something is finds expression in its noncommittal name of “nucleus” (German “Kern”). Perhaps it may be a molecule of a hygroscopic gas. Several such gases occur in small and variable amounts in the atmosphere. The whole subject is still in a highly problematic stage, the only definite fact being that “dust” has been short of its time-honored function as a cloudmaker, and that Aitken’s Staubbäumer has become a Kernzähler.
1923

Describes apparatus and gives sketch.

1937

The polluted atmosphere and crowded conditions of Manchester, as compared to the relatively clean air in sparsely populated rural areas, are believed to be contributing factors to the high death rate. (USPHS)

1933

Granting that the direct cause or etiology is a living organism (virus), certain meteorological or climatological data are presented that point to a definite part that climate and weather play in the production of an influenza epidemic. The weather conditions were considered unusual at the time of the influenza epidemic (1933) in Kiel. During the epidemic Kiel lay in the center of a high-pressure region, and the change in the weather came at the same time that the epidemic ended. Other significant weather factors are humidity, temperature, weather fronts, winds, and polar and tropical air masses. (USPHS)

1935

The influence of the velocity of the flue gas in the chimney, the size and weight of particles, height of the chimney, wind velocity, and the aerodynamic resistance of the particle on the dispersion of flue dust are discussed.

1937

The effects of climate and weather on the incidence of respiratory and diarrheal diseases are reviewed. The evidence presented is almost wholly statistical, and the various contrasting views as to the mechanism of action are pointed out. (USPHS)

1941


1939


1942

Air pollution results principally from the burning of coal, from which noxious gases and solid particles escape into the air. It is estimated that in one Chicago plant 360 tons of sulfur (as H2SO3) escaped into the atmosphere every 24 hours. Five percent of the coal goes into the air as unburned carbon. Wind velocity and direction determine the rate and region in which smoke is dispelled. (USPHS)

1941

Some of the results obtained by the Weather Bureau with the Owens filter in New York City are given.
The potential importance of air pollution may be realized from the estimation that in 24 hours a human being consumes 50 pounds of air, 27 of carbon, and 4.5 of water. Air pollution obstructs light, especially ultraviolet rays, causes smoke fogs, affects buildings and vegetation, and has many economic effects.

Of the meteorological elements affecting measured suspended impurity, wind velocity and wind direction are the two most important and potent. By multiplying each hourly shade number by the hourly wind movement, then grouping the products by the direction from which the wind came, and obtaining averages for each direction, the average "shade-miles" for each wind direction are determined. This value may be considered as a composite index of the darkness of the suspended impurity as it issues from the sources in the given direction into a theoretically stagnant atmosphere, since the wind effects have been eliminated. From the shade-miles data for each wind direction some very interesting monthly and annual rose charts of smoke production in the various directions from our location in Central Park, as well as other types of charts using the sum of the shade-miles from all directions, have been constructed.

The twofold job of correcting a condition of downwash of stack gases in an industrial plant and compiling a theoretical treatise on the behavior of air currents flowing past chimneys and buildings has been undertaken with apparent success. The complete series of wind-tunnel tests made on a scale model of the plant buildings and stacks and the discussion of the establishment of factors of similitude of model and prototype make this report a valuable reference for anyone desiring to make wind-tunnel tests on models. The publication is well illustrated throughout in diagrams. All of the material is drawn from the field of aeronautics. A novel method of tracing the path of stack gases using HSO and lead acetate was employed. (JHT)

1942

A survey was made to determine the extent to which dust emitted from chimneys of powerhouses and gas-manufacturing plants within the city of New York contributed to the general atmospheric pollution. The study was restricted to the measurement of suspended dust, which is understood here to include only solid particles of such size that their settling rate in the atmosphere is not greatly different from the vertical components of air velocity associated with normal turbulence. The general conclusions state that the predominant factor influencing atmospheric dust concentrations in the city is the use of fuel, chiefly for heating. The dust concentration varies inversely as the square root of the wind velocity. The day-to-day variations depend more on wind velocity than on mean daily temperature. There is a seasonal variation of atmospheric dust concentrations in fuel used for heating. The contribution to the general atmospheric pollution of dust emission from power stations is not great enough to be measurable by the methods used in this survey.
COMPOSITION OF AIR POLLUTANTS


The records and findings of the study of the air-pollution survey made in Rochester, N. Y., covering the years 1937-42, are reported.

The figures presented indicate that the amount of rainfall, the number of changes of direction of the wind, and in general changes influence the amount of solids that will be deposited in any receptacle set out for the collection of solids precipitated from the atmosphere.


During 23 days in March 1945 measurements were made twice daily (at 9.30 and 16.00 hours G. M. T.) of the electrical conductivity and the number of small ions, large ions, and condensation nuclei in the air of Paris. The average value per cc. of air is compared with the ion concentration obtained during similar measurements made in March 1935. The results indicate a diminution in the number of condensation nuclei in 1945, accompanied by a diminution in the number of large ions and an increase in the number of small ions, and in the electrical conductivity. The reduction in pollution is relatively greater in the afternoon. The relation of the observed results to the reduction in the amount of fuel burned is discussed. (FA)

1944


Certain basic meteorological processes that affect smoke pollution are considered. The two processes of advection and convection on which pollution of the atmosphere by industrial smoke essentially depends are defined, and their effect on smoke is described.


The association of wind velocity with the degree of smoke in city atmosphere is discussed. The influence of wind velocity in day-to-day concentration is much greater than the influence of temperature.


Practical trials were made of the formulas developed by Schmidt, which showed that by means of modern meteorology many of the earlier difficult problems can be solved. Instead of Schmidt's formulas Schnee recommended six formulas (not given). These relate to the maximum concentration, stack height, and permissible volume of discharge, while the other three deal with the location of the maximum concentration, the concentration in the waste-gas vane, and the air pollution at a given point in space. Results are discussed briefly with 2 graphs and 8 references. (FA)

1945


Observations were made at Parks Airfield, 1936-38. The industrial areas of St. Louis lie in the quadrant NW to NE of the airfield. There was a fog maximum in January and a lesser maximum in June, the latter being due to cold fronts. Air mass analysis of the fog situations is sketched. (APB)


The relation between smoke pollution and the vertical structure of the air is discussed briefly. Three ways are outlined in which it is believed the United States Weather Bureau can assist the engineers concerned with the prevention or abatement of smoke. The first is the vast amount of statistical data on seasonal records of wind fields and vertical pollution, whereas humidities, and horizontal visibilities that are available for the use of smoke-prevention engineers. Second, the United States Weather Bureau is in a position to offer advice as to location of projected industrial plants (potential smoke producers), which should be taken into account as much as availability of power, transportation, and communications. Third, 12-hour Weather Bureau forecasts of winds and visibilities are available upon request to and Leicester and the vicinity.

It is believed that smoke-prevention engineers could profitably discuss the meteorological aspects of the problem with local Weather Bureau officials.


During the 3 years 1937-39, three officers of the Department of Scientific and Industrial Research were engaged full-time in making systematic observations of atmospheric pollution in the city of Leicester with the full cooperation of the city authorities. The object was not only to obtain information about the distribution and dispersal of atmospheric pollution, but also to find what peculiar thing to Leicester but to secure new basic knowledge about atmospheric pollution that would be of more general application. The present report is an account of the results of this work and of the conclusions, whether of special or general application, which may be drawn from them.

As a result of the observations made during the study it has been possible to estimate both the mean distribution of pollution in and around Leicester and the variations in distribution caused by wind or otherwise. The daily, weekly, and yearly cycles of atmospheric pollution were examined and compared, and a particular study was made of the very large day-to-day variation of suspended impurity. In contradiction to the general impression that this day-to-day variation is due mainly to variations in wind velocity, the conclusions pointed to turbulence as the chief cause of the variability. It is shown clearly that atmospheric turbulence, by carrying down clean air from above and carrying up smoke-laden air from street level, is the most important agent in preventing accumulation of dirt in the air of towns and cities. Once the smoke has been carried up to a height of a few hundred or thousand feet it is carried away and distributed over the country. The extent of atmospheric turbulence and, therefore, of the cleaning process is known to vary greatly with meteorological conditions.

713. IRON AND COAL TRADES REVIEW. Distribution of Atmospheric Pollution. Vol. 150, 1945, p. 400.

It was reported at the joint conference of the Institute of Fuel and the National Smoke Abatement Society that the annual deposition of ash in country districts was, in places, less than 10 tons per square mile, while in industrial towns it might be 100 to 200 tons per square mile and in particular districts it might be as much as 2,000 tons per square mile. It was expected that as the air passed over a town it would pick up more and more pollution, so that the maximum concentration would be near the leeward edge of the town. However, during 3 years of a series
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of observations there were few days when the greatest concentration of either smoke or sulfur dioxide occurred either in the suburbs or in the center of the same town. This suggests that the smoke diffused rapidly upwards as it traveled downwind and, although it still cut off daylight, much of it rose well above the region where it could enter the instruments near ground level. The same is presumably true for sulfur dioxide. Therefore, wind direction is important, for the suburbs, but in the center of an industrial area it has virtually no effect.


To explain the lapse rate changes within a fog during radiative conditions at night, the theory of temperature changes in a fog whose upper portion remained at a fixed level were analyzed. The cooling with time of the top surface of the fog is given by \( T - T_0 = \frac{4}{3} b (h + v) \) where \( b \) is the effective nocturnal radiation. Curves are plotted connecting cooling and time for different values of the eddy diffusivity. The equation is compared with that derived by Brun and checked against results obtained by Heywood at Leafield. (FA)

1946


The seasonal dustfall pattern in Chicago is more marked and, as a result, the average wind velocity pattern is different from the seasonal coal consumption pattern. Thus, it appears that the amount of dirt picked up and blown around by the wind is more important than the dirt coming directly from chimneys as the result of combustion of coal. The average dustfall and wind velocity reach a peak in March. However, the average coal consumption reaches its seasonal peak in January. It is possible that March is the dustfall high period because it is after the winter’s ice and snow have melted, releasing dirt on the ground and on rooftops and before vegetation has grown enough to trap dirt or hold the soil. It is likely that in the places where dirt first comes to rest after entering the air were cleaned, surfaced, or planted to prevent the dirt rising again, the dustfall amounts would be substantially reduced. Dustfall has lesser peaks in October and May when coal consumption is rising and falling, respectively. It is possible that these are the results of average high wind velocities, coupled with less efficient firing during the spring and fall when furnaces are not operated at the most efficient high rates but when they are discharging relatively more smoke per unit of fuel consumed, thus contributing enough dirt to the air to show as minor peaks in the seasonal dustfall pattern. The seasonal variation of the visibility measure “haze, smoke, and dust” is greater even than the coal-consumption variation and reaches peaks at the same time as the winter and summer temperature conditions and the phenomenon of inversion seem to affect the visibility measure more significantly than coal consumption and smoke discharge, and some questions have been raised about the precision of the observation methods employed to record these data.

The precipitation seasonal pattern for Chicago does not have any clearly evident relationship to the dustfall pattern. In broad general terms, however, it is true that during the summer months when the precipitation is above average for the year the dustfall pattern is below average for the year. There is evidence, however, that this is more due to such things as vegetation and low average wind velocity than to precipitation alone. (FA)


The smoke problem divides into two main parts, the smoke problem and the dust problem. Several years ago Pittsburgh undertook an elaborate dust collection, extending over 3 years. The deposited material from 100 locations was weighed and analyzed for volatile matter, fixed carbon, ash, iron, silica, and other elements. Cus- tomary dust-collection methods were also used. The data have yielded nothing definite regarding the efficiency of combustion in the city. This conclusion has been verified by a more recent test with an electric precipitator and a recording tape, during and after a steel strike, when the mills were not operating. With the mills closed, the record showed 1.77 arbitrary units of dust per hour. With the mills at 60 percent capacity, the figure was 1.61, and at full operation, 1.68 units. The difficulty with this test was that most smoke or dust is recorded mornings and nights, when atmospheric inversion produces moisture which carries the dust with it. In the dust-collection tests, the deposited material includes organic and inorganic dusts that have blown from some distance, and the volatile matter and fixed carbon includes constituents of the organic dust. On Sundays and holidays under a heavy atmospheric lid there was a heavy deposit, while on clear working days the dust was light. In a dustfall really measures weather conditions and is not a true measure of combustion. Direct visibility tests, such as are constantly made by the United States Weather Bureau, likewise do not measure smoke pollution, because there is no instrument that will differentiate smoke from dust, fog, and haze. The Weather Bureau observations, then, should be called “visibility record” or “air pollution,” rather than “smoke observations.” Also, the points of observation are too few to have a representative picture of conditions over the city. (APB)


By a combination of mathematical theory and experimental verification investigators have worked out the behavior of smoke from three different types of source: (1) Puff of smoke, for example, from a smoke shell. (2) Continuously emitting point source, for example, a smoke bomb or a chimney. (3) Continuously emitting line source placed acrosswind, for example, roof of smoke generators. (4) Continuous area source, with special reference to pollution found within the area, for example, an industrial town. Some of the effects of wind speed and turbulence are demonstrated by numerical methods. Diffusion of smoke along a vertical line, in a wind, in a wind double the former speed, and in double turbulence, is shown. Distribution of smoke from momentary and continuous area-sources is considered. The conclusions reached are: Doubling the wind speed or doubling the rate of diffusion reduces the concentration of smoke in line downwind by a factor \( \frac{1}{2} \) where the source is a row of chimneys in line acrosswind. If allowance is made for lateral diffusion acrosswind, doubling the wind speed or doubling the rate of diffusion halves the axial concentration of smoke downwind from a single chimney. In any given wind speed, the concentration of smoke in central Leicester decreased linearly with increasing lapse rate, and any given difference in these data represents the difference in the concentration of smoke in central Leicester varied at a rate proportional to the inverse square root of the wind speed. (FA)


The investigator may wish to obtain quantitative estimates of the average magnitude of some climatic factor
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on one or more areas of land. This objective is usually obtained by establishing stations or gauges over the area and obtaining simultaneous records over a period of time. The placement of one permanent station in each area and the use of two or more randomized positions per area, which are moved after each of a series of short time units making up the whole period, are suggested. In this way variations of both time and position are sampled simultaneously. Thus, the records obtained from the fixed instrument and the moving ones can be employed for calculating more reliable average values for each short time unit. It is shown that with factors that exhibit variations in both space and time the described sampling methods are likely to show a substantial gain in efficiency as compared to methods commonly employed. (CLAC/UCLA)

1947

719. EDINGER, J. C. Meteorological Aspects of Air Pollution in the Los Angeles Area. Los Angeles Office of Air-Pollution Control, 1947, 15 pp. (mim.)

The results of an investigation of the meteorological aspects of air pollution in the Los Angeles area, undertaken by the Meteorological Department of the University of California at Los Angeles for the Los Angeles County Office of Air Pollution Control, are presented. Part I gives the general plan of the report, Part II the results of the investigation in simple nontechnical language, Part III detailed analyses and case studies, and Part IV a concise statement of the meteorological factors affecting air pollution and tentative conclusions with regard to the nature and location of pollutant sources. (APB)


The possibilities of controlling atmospheric pollution by varying the emission of the polluting substance from large plants according to weather conditions are discussed, a procedure used in conjunction with a program of absorption of gases, which has been employed successfully at the plant of the Consolidated Mining & Smelting Co. of Canada at Trail, B. C. The various ways by which smoke from large plants, with tall stacks operating at high temperature, reaches the earth's surface and how a reduced emission of gases by plants in the early morning hours is effective in preventing smoke from the surface in objectionable quantities are described. (APB)


Laboratory experiments show that as the apparent contrast of a square test object situated behind a smoke layer is decreased a point is reached at which the object appears as a light patch of unrecognizable shape. On decreasing the apparent contrast a little further the object becomes completely invisible. A study of the conditions under which the apparent loss of definition occurs was carried on simultaneously with the study of total obscuration. The optical density of smoke required to produce loss of definition was found to be linearly related to the logarithm of the ratio of object to cloud brightness, in close correspondence with the relation found for total obscuration. Critical range of the experiments the minimum optical density of smoke associated with loss of definition was from 12 to 23 percent less than that associated with total obscuration, the magnitude of the difference depending on brightness conditions. Since the phenomenon of loss of definition is observable in the presence of a veiling glare without smoke, it is probably of physiological origin. (APB)


Various opinions have been expressed regarding the importance of such factors as a "diffusing effect" on account of small angle scattering in determining the visual range in a cloud. If a reduction of apparent contrast and an influence on brightness level are the only important factors, conditions at the obscuration point should be described by

\( P = C B_{10} - D/B_{10} - D + B_{C} \),

where \( B_{1} \) denotes the brightness of an object which has a contrast \( C \) with its background, \( B_{C} \) and \( D \) represent respectively the cloud brightness and optical density in the line of sight, and \( P \) denotes the contrast lumen value. Experiments to test the relation have been performed with an ammonium chloride smoke in a chamber 1.8 m. long. The results indicate that the equation is adequate and that factors not taken into consideration play a negligible role in total obscuration under laboratory conditions. The experiments were performed at various brightness levels within the 1- to 100-millimillambert range. (APB)


A test method used by the Union Electric Co. of Missouri is outlined, which gives a simple, easy means of finding the correlation between the dustfall pattern in a given area and changes in wind direction. The method consists of placing transparent, adhesive paper strips at chosen places, exposing them for any desired length of time and then sealing the exposed strips with clean ones. The paper used is a transparent film of cellulose acetate, with an adhesive on one side heavy enough to catch and hold ash and dust particles or large cinders, and it is held on a horizontal wooden platform supported by a bracket on a distribution pole. Quantitative grading of the samples is accomplished by a device consisting of a selenium-type photoelectric cell and meter used in conjunction with a lamp on a constant voltage source. The percentage of light put out by an exposed transparent sample relative to that passing through a clear sample is used as a density index of ashfall. By chemically dissolving the acetate paper of a range of samples and weighing the resultant ash in each, the relative density can be correlated to absolute quantities of ashfall. Evaluation of dustfall results in relation to wind direction, and velocity can be effectively studied by drawing contour lines through points of equal density of ashfall, or by vector representation of "dust deposit v. wind direction" for each station. A simple recording device driven by clock works, has been developed for hourly record of dust conditions. (APB)


The well-established frequency of fog formation in industrial areas is explained over as due to a general modification of the meteorological conditions there, rather than to an increase in the number of condensation nuclei. None of the substances polluting the atmosphere in great cities and industrial areas can serve as a nucleus for condensation.

The effect on fog formation of size, weight, and capacity of the suspended particles and radiation of heat from their surfaces, as well as temperature at ground level, is presented in technical detail.
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1948


Reference is made to the Donora, Pa., disaster, in which 18 persons lost their lives and over 200 were incapacitated as a result of breathing "smog." The conditions leading to these accumulations are well known to meteorologists. Frequently an inversion of temperature exists in which the air becomes warmer with increasing height before it becomes colder. With temperature inversion, whether or not associated with fog, upward diffusion of smoke is prevented, and it accumulates with the lid or ceiling of the inversion. With high level inversion we have "high fog" in which the air near the ground may be comparatively clear, but with low level inversion the smoke accumulates near the ground with disastrous results, if poisonous impurities are present. As at so many of our industrial plants where iron and steel and chemical industries are situated in valley locations liable to local inversions of temperature, the Donora disaster is a timely warning that every effort should be made to avoid the emission of poisonous fumes and smoke from such establishments. If extraction of the obnoxious ingredients is impossible or difficult, emission should only take place under noninversionary temperature conditions, in which case we need for the improved local meteorological forecasting service proposed by Prof. D. L. Linton in the issue of the Times dated December 7, 1947. (FA)


The interplay of meteorological conditions and the atmospheric pollution produced in cities by burning coal was studied, and how smoke and other polluting matter are removed from town air and how the rate of removal depends on meteorological conditions were considered. The results were reviewed of 3 years' observations on the atmosphere of Leicester, undertaken by the Department of Scientific and Industrial Research, and described in Atmospheric Pollution in Leicester, A Scientific Survey. The amount of smoke at street level in a city is largely determined by the amount of vertical mixing in the lower layers of the atmosphere; the greater the amount of mixing the smaller will be the concentration of smoke or other pollution. The second part of the address dealt with the formation of fogs and the undesirable effects of pollution on fogs. (FA)


The work in Pittsburgh, Pa., in connection with air pollution is described.

In Pittsburgh the question divides itself into two parts—the smoke problem and the dust problem.

There is no way of knowing what proportion of air pollution is smoke in an atmosphere containing fog, dust, haze, and other contaminants. Some 1,400 smoking stacks were cleared in Pittsburgh in 4 years. Visibility has improved, and fogs are cleaner.

The weather is the most important factor in the dust and dirt problems. When inversion takes place a meteorological lid holds the pollution down. Tests show that the measurement of dust conditions does not reflect combustion conditions.


Measurement of meteorological factors concerned with smoke spreading is discussed, special consideration being given to visibility. Relationships between smoke concentration, wind, and temperature stratification are taken up in some detail, separate discussions being made of the two meteorological factors. Various investigations that have related these factors are reviewed briefly. The review includes some of the findings of the writers, who have made a number of correlations between Weather Bureau meteorological data and Davidson's New York City data of 1939-40. The best of these correlations resulted when the wind direction and speed were considered hour by hour for each day and when a straight-line regression formula was fitted to the data. Throughout all of physical reasoning, it is pointed out that smoke concentration should be inversely proportional to less than the first power of the wind speed, a conclusion in agreement with statistical findings of other investigators, most of whom have decided upon a power of 0.5. The importance of temperature inversions in depleting the underlying air of pollution is also brought out. (Authors' abs.)


A daily cycle of air conditions can exist over a highly industrialized area, in which topography, location, and the seasons combine to create polluted atmospheric conditions. (FA)


Detailed studies and improved standards of living demand that excessive pollution of the atmosphere be prohibited in areas of dense population. The Los Angeles smog problem results from the topographical and meteorological features of the area that control the escape of the industrial and domestic pollution. Elimination of the nuisance will require more rigorous standards than those in other cities where the wind and normal atmospheric turbulence rapidly diffuse the contaminants.

Exact information on the nature of the smog is still lacking, but certain aspects of the problem are related to the general properties of aerosols. It is estimated that the nonhygroscopic, nonvolatile particles are approximately the size of those we might expect to find at concentrations of about 0.1 mg. per m². The contributions of sulfur compounds to the smog and eye irritation are discussed, and methods of eliminating them from industrial gases are reviewed. New developments in equipment for the control of dust and fumes are described. These and other methods of control of industrial contamination give promise of success in alleviating the condition. (34 refs. cited) (Author's summary)


By comparing the measured distribution of the scattered radiation in a hazy and dusty atmosphere with the theory of the scatter of light by small particles, it has been found that the majority of the small droplets in the atmosphere have radii of about 10⁻⁴ mm. This agrees with the size generally accepted for the particles forming the nuclei of condensation for the saturated vapor contained in the air. The biggest dust particles thus do not seem to have an influence on the distribution of the scattered radiation. To make sure that the measured values of this distribution are not affected by secondary diffusion, a calculation was carried out that
showed that secondary diffusion has only a minor influence on the distribution of the scattered radiation, thus indicating that the above conclusions are basically correct. (IHD)


Contrary to common belief, surface winds play comparatively little part in carrying away smoke; no great accumulation of smoke could be detected in surface air blowing across Leicester. It was concluded that the smoke tended to spread quickly upward, after which it was blown away horizontally by the stronger winds in the upper air. This accounted for the greatest concentrations of smoke in the surface air always being found near the city centers. It was also noted that atmospheric turbulence was usually greatest in the middle of the day when the sun was high, as well as in clear, windy weather, so that daytime ordinarily was best for carrying out any operations, such as stack blowing, which involved the production of suspended impurities near the ground. (APB)


The smog problem in Los Angeles occurs in the summer and fall rather than in the winter, as elsewhere. Temperature inversion in which the air temperature is as much as 30° higher than surface temperature is known to occur. Air is then held on the ground and smoke lingers. Smoke sources are tabulated with indicated control measures. The smog contains components or components that are irritating to the eyes. An investigation of sources of irritation was unsuccessful, so that the article remains unidentified. The possibility that a change in gases or chemicals may occur after they have been released into the atmosphere is suggested. Meteorological and airplane investigations are being carried on to gain additional knowledge with regard to pollution source. (USPHS)

1949


Two significant factors are mentioned as of interest to an increasing number of meteorologists in air pollution. These are (1) the growing magnitude and (2) the ill-advised location, weatherwise, of certain polluting sources.

The meaning of meteorological control and its role in the solution of the problem of atmospheric pollution and facilities available to industries faced with such problems are discussed. (10 refs. cited)


Describes work being done on the Brookhaven National Laboratory and discusses the difficulties involved. Analyzes effects of stack design and meteorological parameters. (APB)


A chart shows seasonal variations in temperature, precipitation, dustfall, wind velocity, coal consumption, and the visibility measure "haze, smoke, and dust" in Chicago. Various conclusions are drawn, one being that variation in dustfall, following more closely that of wind velocity than that of coal consumption, is not so much due to factory, locomotive, apartment building, and home chimneys as is usually thought. (APB)


Available data and information on the dispersion and spreading of gases and fine dusts discharged into the atmosphere from chimneys are summarized.

The following points are stressed: Airflow in the atmosphere, the influence of aerodynamic factors, effects of exit gas velocity and buoyancy, influence of buildings and terrain, examples of studies, meteorological factors, theories of diffusion, atmospheric phenomena, and inversion of wind. (22 refs. cited)


The weather conditions that gave rise to the Donora Incident are described, based on news reports, Pittsburgh airport weather data, and Donora weather report data. (USPHS)


Monthly, seasonal, and annual percentage frequencies of the visibility ranges adopted by the International Commission for Air Navigation are tabulated for the synoptic reporting stations of the British Isles and a few additional stations from which comparable observations were available for the 3 hours, 0700 G. m. L., 1300 G. m. t., and 1500 G. m. t. (APB)


The following points are presented and discussed: Prevalence of ground fogs in the Appalachian valleys; relation of industrial pollution to fog; influence of air movement; lapse rate; diurnal cycle of air circulation; and stable atmosphere.


Meteorological and topographical conditions in the Los Angeles Basin cause the retention of dust and fumes, frequently for several days. Eye irritation and limited visibility are characteristic of the resultant smog. Studies of the aerosols in this area have been undertaken by Government and private laboratories. Methods and equipment used by the Los Angeles County Air Pollution Control District in identification of industrial contaminants are described. The roles of sulfuric acid mist and metallurgical dusts in smog formation are discussed. (FA)


It is shown that fogs form in atmospheres where the humidity is well below 100 percent, provided condensation nuclei are present. Fogs form at a lower humidity in urban than in rural districts. The difference is neither altogether explained by combustion nuclei alone nor by salt particles alone. The results of the experimental work favor the hypothesis that the number of hygroscopic nuclei increases with the humidity. The data show that the drops in fog at the Los Angeles Municipal Airport are the same size as those found in stratus over the ocean. This suggests that there is a preferred size for drops in stable air clouds, and fur-
ther cooling results in more nuclei becoming active, rather than the further growth of existing drops. (116-117)


Natural pollution of air by volcanoes, desert winds, etc., is compared with that made by man, and mention is made of the effects on population. The effects of topography and meteorological conditions on air pollution are also discussed. Pollutants could be prevented from escaping into the air, or provision could be made for controlled emission to take advantage of weather conditions that would favor their dispersal. (FA)


Results are given of a study made at the meteorological laboratory of Pennsylvania State College on the effect of air pollution on fog density and duration as determined by concentration of condensation nuclei. Fog density was found not to be affected by variations in air pollution, but fog duration increased continuously with increasing air pollution. (17 refs. cited)


At the site of the Brookhaven National Laboratory micrometeorological investigations are being conducted to determine the weather conditions under which radioactive waste gases from a nuclear chain reaction pile will be harmlessly dissipated. Laboratory investigations are in progress into the effect of condensation nuclei on the persistence of fog in industrial areas. Another project deals with the relationship between pollution and visibility through air. A method is being developed by which the relative size distribution of the nuclei can be measured. (APB)


The condition of dissolved nonpolar gases in water solution is entirely a matter of speculation. There is evidence that bubbles small enough to escape observation are very persistent and that the properties of water are considerably affected by their presence. The supersaturation of vapors in the absence of nuclei is subject to thermodynamic treatment. The Thomson equation is no longer valid when the single drop ceases to determine a liquid phase. The drop ceases to constitute a liquid phase when the number of molecules becomes small enough so that the share of each molecule in the (colligative) entropy of the drop becomes considerable. The drop now becomes a molecular aggregate in a homogeneous equilibrium, and a definite limit to supersaturation is established. Experimental data are in general agreement with the conclusions of this theory. (6 refs. cited) (Author's abs.)


During the period January 1, 1948, to September 1, 1949, a study of the concentration of sublimation nuclei in the atmosphere was made at Mount Washington Observatory in New Hampshire. The results of this study are presented. A sublimation nucleus is defined as a foreign particle on which an ice crystal will grow by condensation of water molecules directly from the gaseous to the solid phase.

The method used for assigning concentration values to the observations made on Mount Washington is described. The most significant fact resulting from this study is the rarity of relatively high concentrations of active sublimation nuclei in the atmosphere.

If the results observed are a true representation of the average mean condition of the atmosphere, it is obvious that by the artificial introduction of sublimation nuclei into the atmosphere, man possesses a powerful method of modifying many cloud systems.

The roles of spores and bacteria and industrial smokes as sublimation nuclei and the relationship of sublimation nuclei to meteorology are discussed. (12 refs. cited)


Some of the laboratory and field activities in the realm of experimental meteorology are summarized.

Some properties of natural snow particles in the free atmosphere and their electrical characteristics observed in snowstorms are given. A method for classifying snow particles is listed, and the typical varieties are illustrated by photomicrographs.

A method of preparing planar replicas of snow crystals and of snow on the ground are described. Techniques for detecting sublimation nuclei in the free atmosphere are given, involving the use of a cold chamber and supercooled films supported on rings or on thin plastic films.

A description is given of the technique used in simulating natural clouds in the laboratory, and the basic procedures that should be followed are listed.

The role that certain types of dust particles play in serving as sublimation nuclei is mentioned and the results observed with a considerable number of typical samples and their effectiveness at various temperatures.

The effect on the crystal habit of ice produced by the blocking action of absorbed surface-active polar molecules is shown.

Some of the aspects of the cloud modification studies initiated in 1946 and subsequently carried out as Project CIRRUS, a joint Army-Navy-Air Force-General Electric research project concerned with the physical nature of precipitation in snow and rain, are described. A few of the observed results are mentioned, as well as the relationships that are believed to exist in the unstable clouds. (20 refs. cited) (Author's abs.)


A technical and theoretical discussion of atmospheric turbulence. The subject has been considered throughout as a branch of mathematical physics. An account of dynamical meteorology has been attempted that is recognized as a study of major importance, not only because of its intrinsic interest and the fundamental part it plays in the science of meteorology as a whole but also because of its significance in economic, military, and industrial spheres.

The monograph deals exclusively with the properties of atmosphere near the ground (air extending from the ground to not exceeding 100 meters), the most important region for turbulence.

A sensitive anemometer placed anywhere within a few hundred feet of the surface of the earth shows that the motion of the air consists for the most part of a succession of gusts and lulls accompanied by rapid and irregular alternations in direction. This feature, immediately obvious to anyone watching smoke from a chimney or rippling waves passing over a field of corn in summer, is more than a meteorological curiosity. The steadiness of the wind has much to do with the shape of life as we know it, for it is this property which largely controls such apparently dissimilar phenomena as the
COMPOSITION OF AIR POLLUTANTS

warming of the atmosphere near the surface of the earth, the evaporation of water from land and sea, the scattering of pollen and the lighter seeds, and (most important in an industrial age) the removal of pollution from the air above great cities and crowded centers of industry.

The systematic study of atmospheric turbulence, that is, of the eddying of the wind as a diffusing process, has been of recent origin and all the major developments have occurred within the last 30 or 40 years. To a large extent the subject has advanced with the study of aerodynamics, and any systematic account must therefore be made with a background of fluid motion theory. This theory is discussed in detail. Also are discussed the meteorology of the lower atmosphere, mixing length and statistical theories of turbulence, diffusion of the atmosphere near the ground, and turbulence in a variable density gradient.


A few of the rather simple principles involved in the effect of the weather factors on local pollution are mentioned. These principles are illustrated by a few cases, particularly by the case of Donora, and the possible estimation of smog hazard at selected sites is discussed briefly.


Faets are given concerning the lethal characteristics of smoke. (FA)

1950


Smoke plumes emitted from elevated sources during inversion conditions and characterized by negligibly small settling rates remain aloft for many miles over flat terrain. Photographs of plume patterns taken at the Brookhaven National Laboratory are presented to show the nonisotropic character of diffusion during conditions of strong stability.

As relatively rapid dilution occurs within the first few meters of a stack, the diffusion problem is treated as a two-phase problem. The first phase may be termed the aerodynamic phase, the second phase, the meteorological phase, and the process.

The classical diffusion equation is reexamined for possible application in the inversion case. If concentrations of the effluent within the first 1 or 2 kilometers of the source are desired, it is desirable to treat the source as an area source of finite concentration rather than a point of infinite concentrations. (AIHOM)


Progress in stack meteorology, a branch of meteorological engineering, has been made by clearly demonstrating that the earth's atmosphere is not an infinite sink into which man may pour an unlimited quantity of pollutant. With a given array of sources and effluent rates, the pollutant that may be disposed (by discharging it) into the atmosphere depends on the weather and on the amount of pollution that is "tolerable" or otherwise permitted, not merely in the immediate vicinity of the source but sometimes for distances of many miles. Outstanding weather examples are discussed briefly. Meteorological control, as established by Hewson at Trail, B. C., and Beers and coworkers at Brookhaven, illustrates the possibility in this new field. Stress is laid on the fact that in many applications specific studies are required for individual sites and polluting sources, and that the meteorological engineer must supply in advance the best possible information of the effect of weather on the operation or activity at hand. This requirement means that meteorological engineers must be proficient not only in the accepted field of "pure meteorology" but must also become proficient in the operating practices of clients and capable of interpreting and explaining an effective and efficient operation. A vast new field is opening with the present necessity to obtain a clean atmosphere.


Recently in St. Louis, Mo., the American Meteorological Society at its 30th anniversary meeting agreed that long-term studies of meteorological conditions predict probable minimum dispersing conditions and the average deviation from the mean. This information at hand, air-pollution control can be engineered into the plant. Control depends on three techniques: (1) Process design to eliminate pollutants; (2) removal of the pollutants from the exhaust; and (3) effective use of the existing microclimate.


Because of the increasing participation of the industrial hygienist in air-pollution studies, it is now required that he learn to use some of the tools and techniques of the meteorologist.

The various meteorological factors influencing air pollution, such as stack height, distances from the stack, wind speed, and atmospheric turbulence, are reviewed. The mathematics of turbulent diffusion, as covered by Sutton (Quart. Jour. Roy. Meteorol. Soc., London, vol. 72, 1946, p. 237), with a view of the parameters is discussed. From this mathematical treatment, the simple equations for estimating maximum ground level downwind concentration and its distance from the effluent stack are also presented. Air-pollution surveys have been conducted at various plants, and in this discussion a brief résumé is presented of three separate applications of the value of these equations to the industrial hygienist.


An airfoil pitometer for simultaneous measurement of flow direction, velocity, and static pressure is described, and its performance in turbulent and streamlined flow is presented. Its size and sensitive angle-of-flow-indicating characteristics make it suitable for measuring point conditions in curved flow streams encountered in elbows or cyclone dust collectors. The small double-chamber type of airfoil pitometer has theoretical and experimental advantages over any existing types that have been previously described. (IHED)


The American Steel & Wire Co., which operates the Donora zinc works, has set up its own weather
station in cooperation with the U. S. Weather Bureau as part of its program to guard against any future emergence of data of the program were outlined at a meeting of the Donora Chamber of Commerce. Everything is being done, short of closing the plants and moving away, to eliminate every conceivable element of chance. The company has engaged the services of a weather-forecasting agency, which utilizes the information collected by the U. S. Weather Bureau, as well as daily temperature readings from Donora and the Pittsburgh Airport, and will move swiftly to provide, first, an alert, and then a final warning in case there is an indication of a recurrence of the weather conditions that marked the smog period. If a warning should come, then all citizens, manufacturing industries, railroads, and river boats can take appropriate action to minimize the possibility of danger. In addition, the company has a full-time meteorologist on duty in Donora. (HID)


The basic meteorological factors that effect the dispersion of effluent from tall stacks are discussed in terms of their utility in determining a pollution climatology. These factors include: Wind speed, direction, and gustiness, and the vertical temperature gradient. It is shown that, for tall stacks, all of these factors can be approximated from the record of a single anemometer and vane mounted near the level of the stack top.

Using data collected at Upton, N. Y., an operational climatology is developed that combines the variables into a single pollution index. Examples are shown of such an index. The limitations of the index result both from the lack of a film theory and from non-meteorological factors such as local topography and the nature of the effluent.


The two factors most directly concerned in the dispersion of atmospheric pollutions from their source are given as wind and vertical temperature gradient or lapse rate.

An understanding of meteorology and its relation to air pollution is necessary in planning the zoning of cities or the development of new industrial areas. If pollutants are to be emitted, the general climatology of the area, particularly with reference to the prevailing wind regime and local topography, should be studied for the selection of the most favorable site. The optimum height of the stacks may also depend on climatic conditions.

The engineer and the meteorologist, working together in planning site location, position, and height of the stacks and instituting a program of meteorological control of effluent release, should prevent many of the errors of the past which have gravely affected the safety and welfare of the people.


This discussion, presented at the Air Pollution Institute held at the University of Michigan, February 6, 7, and 8, 1930, is concerned with the weather aspects of the atmospheric pollution problem, including the complicating effects of topography. The three practical problems discussed are: (1) The specification of the meteorological factors involved, and how they affect the concentration of air pollutants; (2) the evaluation of the weather factor as a potential hazard in a selected locality; and (3) the avoidance of extreme pollution hazard by judicious selection of plant sites and use of weather forecasts.

The specification includes precipitation, air motion, and shielding effect of fog or smoke.

Evaluation estimates of the probable characteristics of a selected locality, with respect to atmospheric pollution and extreme smog hazard, is now recognized as important, both for the location of plant sites and for any decision as to the necessity of precautionary measurements against excessive local pollution of the atmosphere in established industrial communities.

From the weather angle there are two methods of avoiding or mitigating the nuisance of atmospheric pollution—careful consideration of location of plant sites and anticipation, by suitable weather forecasts, of exceptionally unfavorable smog conditions so that necessary precautionary measures can be taken.

1951


This monograph includes a number of useful papers with regard to meteorological aspects in air-pollution work. Most of the papers deal with micrometeorological aspects of the problem, although one paper covers instrumentation for air-pollution measurement.

The papers presented by the Brookhaven and New York University groups are very good and deal with situations made in distribution of oil fogs and in wind tunnel evaluations. There are several other papers covering forecasting and wind-velocity effects that will be useful to industrial hygienists concerned with air-pollution work.

The collection of papers represents a valuable contribution to the field of micrometeorology and should be in the hands of all those concerned with air-pollution problems. (AIHOM)


A proposed plant location should be carefully surveyed and evaluated for existing air pollution, preferably with the aid of studies involving physical and chemical tests. The industrial hygienist knows that any future investigation and control will eventually fall upon his shoulders.

At Donora, Pa., it was observed that a mountainsous area can be conducive to formation of a weather condition known as inversion. When this condition prevails, any discharged fumes and dusts may stay near the plant site without normal dilution or dispersion. Moreover, any plant in a valley is limited as to stack height, and air contaminants have been known to follow the course of valleys downwind for several miles, damaging plant life.

"Airmuffin" from a plant situated near woodland might be damaging to trees. It is also conceivable that, over a long period, there may be enough deposition of solid flammable material to constitute a fire hazard. Plant location, with respect to farmland and residential areas, is important because of potential odor nuisance or chemical damage to buildings, crops, and foliage, or livestock eating contaminated foliage.

When location of a plant site is being chosen, neighboring plant processes should be considered for possible mixing of two or more airborne materials that might produce undesirable odors or visible fume. A review of some simple chemical reactions should serve to indicate the possible combinations that would produce such fume.

Hydrochloric acid and ammonia constitute an example. At a certain plant it is reported that these two gases would come together, forming an ammonium chloride fog that would form a dense blanket and carry downwind about the plant site and over into adjoining property. On another day, it would form at another spot, depending upon wind direction. It was not until a number of chemical reactions had been checked and
process vent stacks examined that the two offending stacks were located. Hydrochloric acid was escaping from one stack and ammonia from the other. Although 100 feet apart, occasionally the two gases would escape at the same time when wind direction was just right to carry the discharged gas from one stack directly across gas from the other stack. A similar situation may occur when waste vapors are discharged to a stream containing traces of ammonia.


Outside air pollution is much more susceptible to weather variations than pollution inside factories, and most of the paper deals with outside pollution. Complex factors involved are discussed, and theories are presented in a qualitative sense without giving numerical measurements. The factors include movement of pressure areas, wind velocity, temperature, local terrain, and daily and seasonal variations. The quantitative significance of these relationships should be determined by gathering and correlating long records of industrial health and weather. To a smaller degree, air conditions inside the plant are affected by meteorological conditions. At times the inside air may be less polluted than the outside air. Ventilating systems that operate efficiently when the temperature inside the building is much higher than outside may fail when the reverse conditions apply. Also, in cold weather the ventilation may be restricted by closing the doors and windows, and, therefore, polluted air may not be effectively removed. (11 refs. cited)


Drag-free anemometer characteristics and electronic data techniques combine in a self-contained system to provide accurate recordings of wind direction and wind speeds from a threshold below 1 to 30 m. p. h. The unit is energized by its own battery supply and weighs 100 pounds with batteries.

Speed and direction recordings are made on separate standard pointy 0 to 1 millimeters, which are not supplied in the standard system. High resolution of output data permits wide choice of recorder-chart speeds with great flexibility in the quantity of detail obtainable. Two anemometer speed ranges are provided: 0 to 10 and 0 to 30 m. p. h.

Because of the portability of the equipment, its freedom from on-site adjustments, and its sealed and permanently lubricated moving parts, the system is suggested for smog surveys and investigations of the light winds that have a major influence on the buildup of pollutants from the smokestacks and other sources of industrial atmospheric contamination.


Reviews literature on effect of variations in wind velocity, temperature, precipitation, forests, and altitude on concentration of atmospheric dust and bacteria. Diagrams and graphs. (APB)


Three basic meteorological parameters determine the history of a contaminant after it enters the air—speed and direction of the wind and turbulence of the atmosphere. There has been three main problems of minimizing pollution-changing industrial plant process so that fewer wastes are evolved, removing the contaminants in the plant and emitting them in accordance with meteorological conditions. A combination of the last two methods has been used successfully by the smoker at Trail, B. C. (APB)


The diurnal and seasonal distribution of pollution in two Canadian industrial cities is examined. The relation between the vertical distribution of sulfur dioxide in the atmosphere and the amount of turbulence near the ground is considered, and previous theories are discussed. (APB)


The influence of meteorological conditions, including rainfall, temperature changes, wind speed, direction and turbulence, frost, etc., on atmospheric pollution is discussed, as is the influence of pollution on climate. (APB)


Only recently has the importance of meteorology in studying air pollution been fully appreciated. Meteorological conditions are a controlling factor in the rapid dispersal of contaminants in the atmosphere. During World War II, the armed forces used kite balloons for determining lapse rate and relative humidity at various altitudes. Using this principle, methods have been developed for measuring wind velocity and for securing samples of particulate matter and contaminant gases at 500 feet and higher. Recent experimental work has developed a technique for studying air-flow patterns over buildings in hilly terrain. Smoke grenades, supported by kite balloons, are fired at various altitudes above the plant. The flow pattern of the air is obtained by observing and photographing the path of the smoke from these grenades. Photographs illustrating the differences found in firing grenades at various heights and under various meteorological conditions are presented.

The relation between wind direction and dirt fall, in industrial areas, has been given considerable attention. Equipment has been designed and is described for collecting separately the dirt that falls when the wind is blowing from various directions. Equipment is in the design stage for relating aerosol concentration to wind direction. A better analysis of the air-pollution problem will be possible by using these new techniques and equipment. (12 refs. cited) (Author's abs.)


Two sets of experimental gustiness profiles in the lower layer of the atmosphere under a range of stability conditions are presented. One set was obtained in the lower 200 feet over a desert in Arizona, and the other set was obtained in the lower 2,000 feet over Los Angeles, Cali. These measurements were made with the aid of British bivanes, and by observing diffusion rates of smoke plumes. Some interpretations of the diurnal variations of these gustiness profiles are given. (APB)


Meteorology is a practical factor in any study of air pollution, for it can aid in abating the problems of chronic air pollution and may prevent them from becoming acute. Industrial hygienists should have a fundamental understanding of (1) air movement in the free atmosphere, (2) common topographical modifications of weather, (3) the use of meteorological methods needed to measure the temperature gradient and the turbulence characteristics of wind throughout the pollution diffusion layer, and (4) meteorological
measurements of significant concentrations of pollutants. (17 refs. cited.) (A1HOM)


Plant location based on the weather has been advocated as a major step toward solving the problem of industrial air pollution. The cost of study of the "air-pollution potential" of a possible plant location represents less than a fraction of the total investment in the plant and can pay large dividends in good will, efficiency, and even labor relations.

The time has come when, in addition to the other considerations of proximity to raw materials, cheap and usable water, transportation facilities and labor, the weather must also be considered as an important factor in plant location. This new factor will grow in importance proportionally to the inevitably increasing severity of air-pollution-control ordinances throughout the country. A company can design and build a plant that will not be an air-pollution hazard if it is armed with weather data from which to evaluate possible plant sites.

The warning was sounded that more of this type of industrial planning will be necessary in the United States. The cost to industry will be great if a chain reaction of air-pollution damage suits is directed against it, and it would cost far less to know the facts about its contribution to polluted air, both present and future.


A great explosive eruption, like that of Krakatoa in 1883, throws many tons of dust into the air. Dust in the atmosphere from that outburst actually caused red sunsets for 2 years all over the world. Thus, there is the possibility that volcanoes, in addition to causing destruction by their eruption, will actually affect the weather of the whole earth.


Discusses meteorological control of air pollution. It is defined as the study of the effects of such phenomena as wind and temperature effects on the dispersal of gaseous discharges into the atmosphere.

Dispersal of waste gases into the atmosphere may be accomplished safely by a combination of the following factors:

1. Proper plant location with due regard to prevailing weather conditions, topography, and the surrounding neighborhood.
2. Determination by the use of Sosanquet's equation of the preferred stack height to be used to insure minimum gas or aerosol concentrations at ground level. (However, if short stacks are used, Sutton's equations will probably be more accurate. In this instance, the character of the plant's neighborhood must be carefully considered to be sure that no damage or annoyance to people will result from the plant's operation.)
3. Control of the rate of discharge with daily local weather conditions to insure that the dispersal power of the atmosphere will not be exceeded.
4. Installation of proper control equipment so as to be able to meet the predetermined maximum emission rate.
5. Alteration of the type of discharge by incineration or by chemical means. (7 refs. cited)


The current status of the forecasting program developed for nuclear reactor operations at Brookhaven National Laboratory is discussed in some detail. The forecasting technique is based primarily on empirical relationships between synoptic and micrometeorological variables as they have been determined by observation and climatological studies. Considerable attention is devoted to classification and prediction of horizontal gustiness, which is used as a measure of turbulence in the meteorological control scheme. Application of the forecasts to control of the nuclear reactor is also discussed. (APB)


The influence of meteorological parameters in the dispersion of cooling air from the Brookhaven nuclear reactor stack has been under investigation for 3 years. The empirical results obtained with an oil-fog test effluent are compared with theoretical expectations, and a method of resolving these differences is described. The nuclear reactor itself has been operating for the past 6 months, providing a new source of data on the dispersion of stack effluent. Unclassified aspects of the relationship between oil-fog and radiation data are presented insofar as they have been established at the present time. Brookhaven experience has shown that the meteorological factors of importance in certain pollution problems can be forecast with an accuracy comparable to that achieved in standard, public weather forecasts. The basic features of the forecast program are described briefly. (12 refs. cited)


Around-the-clock air sampling is being done in Detroit by means of a mobile unit in cooperation with the Bureau of Sanitation and Abatement. To determine specific sources of pollution and the effect of micrometeorological influences on atmospheric contaminants, various weather instruments are used. Continuous charts of wind direction and velocity are made by means of a Bendix-Fries anemometer. The vane propeller mast of this instrument is mounted on a specially built platform on top of the truck. On the platform is a Universal rain gauge. This gives an S-data recording of rainfall to the nearest 0.005-inch.

Bendix-Fries hygrothermographs give a constant recording of temperature and humidity and are mounted within a specially constructed weather shelter attached to the mast. Also attached to the mast of the truck are two filter paper collectors. A device for dealing with sulfur dioxide readings may then be correlated with points where the plant direction agrees with the actual wind direction to observe the plants' influence. All of the original data have been condensed by using average values over a 6-hour period.


A progress report is presented of the program of wind tunnel development for atmospheric research,
begin in 1948, being carried on at New York University. An attempt is being made to simulate meteorological and surface conditions as nearly as possible for practically any plausible conditions. The problems encountered in such an endeavor are very complex and difficult. These problems include simulation of atmospheric temperature gradients, and nonuniform characteristics of the air stream in the lower layer of the atmosphere, and pollution conditions at considerable downwind distances.

A wind tunnel for the study of stack-gas dispersion problems has already been developed, which has aided materially in designing the meteorological wind tunnel now under way. The development of this latter tunnel will be limited by the extent of the knowledge of the actual atmosphere. However, the tunnel may prove to be a valuable aid in gaining this knowledge. The work is slow but hopes are high that the venture will be successful. (PHEA)

1952


Meteorological balloons have been used for many years to gather data useful in weather forecasting. They may be used also to investigate air pollution. In fact, small captive balloons, with somewhat different characteristics from large, high-altitude one, are already in use at sample air at intervals in studies of smoke and gas emitted from stacks.


The meteorological study, an international undertaking with cooperation between two national weather services, will be aimed at determining and evaluating meteorological factors controlling the atmosphere's property for removing and dispersing contaminants. Relationship between weather and air pollution is discussed as regards need for weather information in this study. The observation network and geographic factors of the area are discussed. (PHEA)

1953


Fairly recent British investigations relating to the problem of the diffusion of matter in the lower layers of the atmosphere are discussed. Research in the Meteorological Section of the Chemical Defense Experimental Station, Porton, Wiltshire, England, is described.


The University of Washington, Department of Meteorology and Climatology, has an installed installation that will provide recorded data for working on many problems of transfer of heat, moisture, momentum, and turbidity in the lower 50 meters of the atmosphere, exchange of heat and moisture across the soil surface, and the diurnal, seasonal, and annual heat budget of the upper 15 meters in the growing season.


Factors differentiating the problem of power plants from those of some other industries include: (1) The usual desirability of location near centers of load, (2) the need for operating to meet the load demand, which often means high loads at times of unfavorable meteorological conditions. Cleaning the stack gases of dust is now being carried to practical limits with available equipment.

Only a start has been made in the investigation of meteorological factors, especially for built-up urban areas, although this is essential to proper evaluation of benefits to be gained from higher stacks, modification of building shape, higher exit gas velocities, etc.


Intrument combines the readings of a cup-type anemometer with the movements of a wind vane and integrates the result, so that values of wind components in four directions over a given time interval can be read directly. (FA)


The behavior of smoke from a single elevated continuous source, such as that at the top of a stack, is of primary importance. Descriptions of this behavior as given by Bosanquet and Pearson, Sutton, Charnock, Lowry, and Barad are reviewed and discussed, and the relative merits of each approach indicated. General factors governing the magnitude of concentrations both near to and distant from the source are described. The effects of the following special factors are indicated briefly: A rapid change of turbulence field at smoke level; frontal surfaces and subsidence inversions aloft; deposition and coagulation of particulate matter; and topography.

Detailed knowledge of the behavior of pollution from multiple sources, such as that from an industrial city, is as yet lacking. Wind, rain, atmospheric stability, and topographic features influence the distribution of contaminants, and the contaminants in turn influence precipitation and fog occurrence and persistence.

Pollution may be minimized to varying degrees by: Changing plant processes; removing contaminants at the source; increasing stack heights and temperatures; and retarding contaminants in accordance with meteorological conditions. Climatological data are valuable in determining the optimum location of a new industrial plant.


Meteorological conditions favoring heavy smoke concentration and its dissipation are discussed. The need for more knowledge of temperature inversions is stressed. (APB)

1959


The Oak Ridge area, having 900-foot hills separated by about 10 times their height, is in an intermediate scale of terrain between rolling country and mountains. An approach to the study of air flow and diffusion at this scale is sought. The small size of the hills, as well as the complex thermal gradients that exist in the atmosphere, renders the usual experimental studies or direct application of diffusion theories somewhat discouraging. However, although neither the power law nor the logarithmic law of vertical wind structures hold rigorously, the parameters derived from these equations show promise of being useful. The diurnal variation of the "friction velocity" u_f suggests the existence of two
regimes, one (the unstable case) in which the shearing stress is the same both within and above the valleys, the other (stable case) in which the upper layer is subjected to a much larger shearing stress. The Richardson criterion, evaluated for the lowest 1,000 feet, shows promise of isolating the two regimes. The unstable regime is characterized by relatively small influence of ground contour on wind direction or speed, while in the stable regime valley channeling predominates and the hills exert a large drag on the atmosphere.


Although the new meteorological instruments that tell about the wind, sky, and atmosphere are teaching more every day about the vast ocean of air, much can be learned from one of man's oldest meteorological techniques, namely, what happens to smoke. Because smoke rises into the atmosphere and because it flows with the wind, it provides a means by which the invisible currents of the atmosphere are made visible.

The direction of the wind, the amount of mixing which occurs, whether rain, snow, or fog forms, the height to which smoke rises, the manner in which it rises, and the direction it flows after it has risen are all useful indicators of the state of the atmosphere. Careful interpretation of what can be seen in the air often can be used as a replacement for fine instruments.


The variations of the potential gradient in fair weather are due to disturbances introduced from the earth's surface that carry space charges but are of low conductivity. Convection processes produce clouds of space charges, positive in the case of rising smoke and motor-car exhaust gases and negative if due to stationary internal-combustion engines. Steam from locomotives and from coke-slaking is positive; waste gases from chemical works, foundries, and gas works are negative. (APB)


An experimental study of the relationship between the concentration of condensation nuclei on one hand, and the duration, transparency of fog, and the size and number of fog droplets on the other, revealed that the concentration increases almost linearly as the logarithm of the nuclei concentration, whereas the transparency decreases only within the range of nuclei concentrations below 100 mm-2, remaining practically constant for higher concentrations. With increase in nuclei content, the size of the fog droplets decreases and the number of droplets increases. However, the proportion of nuclei participating in the condensation process becomes smaller as the nuclei concentration increases.

The relative effectiveness of various combustion products and of the quality of the combustion process in prolonging the fog and in decreasing its transparency has been investigated. Incomplete combustion tends to increase both fog density and duration. The role of oily products resulting from pyrolysis of fuels and of electrostatic charges in modifying the fog properties is discussed.


Phenomena associated with the behavior of individual particles can be understood in terms of known physical concepts if factors, which are insignificant by many orders of magnitude in normal experience, are recognized to be of significance in a scale of values reduced to the mass and size of an aerosol particle. The following topics concerning aerosol particles in the atmosphere are discussed in terms of known concepts, with recognition of significant factors: (1) Gravitational effects and their importance due to the mass and size of an aerosol particle; (2) forces which affect the motion of individual aerosol particles; (3) effect of the electric field in the atmosphere on the deposition of dust particles; (4) washout of dust particles by raindrops; (5) condensation caused by thermal and turbulent motion as it affects the particle size of the atmospheric aerosol; and (6) decay and growth of aerosol particle. (AIHOM)


Basic principles of model operation are outlined, and difficulties of general meteorological application are described. Flow over a rough, irregular surface, such as an urban region, however, may be simulated by model studies. Experimental analytical procedures for such studies are indicated. Applications of results of model tests to pollution problems in urban areas are suggested. (APB)


Downwash of stack gases near a certain plant occurs when the wind velocity exceeds certain critical values. To estimate future occurrences of this phenomenon, it is desirable to know the frequency and duration of those cases in the past in which the critical values have been exceeded. Statistical methods, used in selecting and analyzing a typical year's wind records for purposes of future estimation are discussed. Wind history, valid for the area served by the recording station, is presented in diagrams using a system of probability coordinates. From these data an estimate is made of the frequency and duration of future wind velocities above the critical values. This estimate is valid only for the one plant for which the critical velocities were determined. (APB)


A summary of the recent progress of the meteorology group at Brookhaven National Laboratory is presented. Emphasis is placed on those unclassified aspects of the field of atmospheric pollution, particularly the oil-fog tests, the system of meteorological control, and recent instrumental developments. A brief outline of the future plans of the group is included.


The behavior of a stream of hot gas when emitted into the atmosphere in the vicinity of the ground is of considerable importance in atmospheric pollution. The temperature of the gas in the stack and that of the ambient air can be a weighty factor in determining ground concentrations. A combination of high stacks and high ambient temperatures may do much to relieve the lot of those living in the neighborhood of a source of gaseous pollution.

The following points are covered: Mechanism of entrainment, the continuous point source expression, and some experimental data.
EFFECTS OF AIR POLLUTION
ON HEALTH

1866


Deals mainly with various injurious effects of smoke. Makes a plea for moderate rather than extreme relief measures, and considers the problem largely one of education. (MIR—Bib.)


Discusses how far smoke and the products of combustion arising from various manufacturing processes are injurious to health and what measures ought to be taken to prevent contamination of the atmosphere from such causes. (MIR—Bib.)

1878


A number of animal experiments upon dogs and rabbits are reported to show: (1) The changes in the epithelium of the air passages that are caused by the inhalation of dust; (2) how the dust penetrates the tissue; (3) what passage it used in entering; and (4) what forces impel it forward in the process. Concludes that soot is less harmful to the respiratory organs than is mineral dust. (USPHS)

1882


Smoke is condemned as being depressing and disastrous in its effect on the nature and abilities of workers. (MIR—Bib.)


In this early protest against the smoke menace, those who claim that smoke is healthful are criticized. Smoke is considered a large contributor to urban pallor and debility as well as ill health and maldevelopment of children. No specific causes and effects are discussed. (USPHS)


Describes the obstacles that were met and the methods of combating them. One of the early problems was that the majority of the populace had an aversion to the use of coal because of the disagreeable smoke. Even as far back as the 13th century coal smoke was considered to be very detrimental to health. At the beginning of the 14th century the use of coal, with its consequent smoke, had increased so much in London that a royal proclamation was issued (1306) prohibiting the use of coal. (USPHS)


Gives some space to effect of smoke-polluted atmosphere on health. (MIR—Bib.)

1883


The cause, conditions, and effect of dense smoke fogs on health are considered. Continued fogs are shown to cause greater pollution of the atmosphere and these are of longer duration. Irritating matter is said to be the cause of the increase in death rates after a fog. Following one of the fogs, a severe epidemic of influenza occurred and lasted 6 weeks. The cold connected with fogs is thought to have had much to do with tuberculosis, pneumonia, and bronchitis.

Sodium disulphide and carbon disulphide are listed as the most important gaseous constituents of fogs. Sunlight is decreased by fogs, and this loss is reflected in a higher incidence of rickets and anemia. (USPHS)

1885


Refers to daily determinations of ozone made at the Montsouris Observatory, which have shown constantly diminishing concentrations for a long time under the influence of the north winds that cross Paris. This reduction in the ozone of the air is ascribed to the sulfurous acid in the atmosphere of cities. The following facts are presented regarding the relations between certain epidemics and the absence of ozone from the air:

1. Sulfurous acid exists in the air of cities where coal is burned and its presence there provokes a notable diminution of atmospheric ozone as well as the formation of sulfurous acid.

2. By the very slow but continuous action of traces of sulfurous acid in the atmosphere of manufacturing cities and under the influence of frequent variations in the condition of humidity, the lead peroxide of minium (red lead), which colors certain signs and is generally considered as very stable, is destroyed and sulfated; simultaneously the lead monoxide, becoming free, is transformed into insoluble sulfite, a salt easy to characterize and to determine; the sulfite exists in inverse proportion to the coloration of the red lead. Here then is a new means of studying the atmosphere of large communities.

1890

807. GLINZER, C. Address on the Smoke Nuisance and Its Abatement Before the Industrial Society of Hamburg, 1890. Abs., Mellon Inst. Smoke Investigation Bull. 9, 1914.)

Although smoke is regarded as truly injurious to health in a degree not as yet determined, its twofold qualities are appreciated. Smoke possesses excellent germicidal and disinfecting properties. "Obnoxious vapors and other harmful products carried by the air are absorbed and retained by the material elements of smoke and are finally carried away harmlessly by the rain, so that smoke, on the contrary, can be stumped as a purifier of the atmosphere and a benefactor of the human race." We can safely depend on our instinct, and this tells us decidedly that smoke does not agree with us. (USPHS)
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1892

809. METCALF, W. On Smoke. Proc. Eng. Soc. West Pennsylvania, vol. 8, 1892, p. 23. Presents view that smoke is not injurious to health and that smoke prevention in an iron-manufacturing region is impracticable. To have a smokeless sky, the iron must be oxidized and will therefore be literally burned up. This is too costly and produces more toxic gases than does smoke. (USPHS)

810. WIESNER, J. [The Identity of Lung-Pigment With Soot.] Monatshefte, vol. 13, 1892, p. 371. A reagent is presented by which lignite can be distinguished from charcoal, soot, and graphite in lung tissue. Black lung pigment, which during the lifetime affects in every human being, especially in the interlobar tissue, the true nature of which has not hitherto been sufficiently explained, consists of soot in the form of small dark bodies, which appear as fine, pointlike grains, and show no alteration after weeks of subjection to chronic acid.

1894

811. MEDICAL NEWS. Sanitary Bearings of Smoke-Nuisance. Vol. 64, 1894, pp. 51-52. General and indefinite. (MIR—Bib.)

1895

812. POPULAR SCIENCE MONTHLY. Weather and Mental Action. Vol. 47, 1895, p. 568. Intimate connection is suggested between weather and mental action, and includes testimony of a large employer to the effect that "a disagreeable day yields about 10 per cent less work than a delightful day." (MIR—Bib.)

813. RUSSELL, F. A. R. The Atmosphere in Relation to Human Life and Health. Smithsonian Inst. Ann. Rept., 1895, p. 293. The various constituents of the atmosphere are enumerated, and the relation of each to human life and health is discussed. Air-borne diseases are also discussed. A small, generalized section is devoted to noxious gases. (USPHS)

1896

814. HERMAN, DOUGLAS. Notes on Poisoning by Carbonic Oxide. Jour. Soc. Chem. Ind., vol. 15, 1896, p. 854; abst. Persifor Frazer, Trans. Am. Inst. Min. Eng., vol. 38, 1907, p. 527. Mice, cats, and rats died in a stable 50 yards away from produce plant. Communication was only through loose soil. Mice are very susceptible to CO. The first indication of poisoning is a dizzy, drunken feeling, and cold at extremities. Action of CO and alcohol similar in withdrawing O from the blood, but whereas alcohol stimulates the heart and provides the antidote to a certain degree, CO does not. Affinity of CO for hemoglobin is strong—250 times greater than that of oxygen.

1900

815. ENGINEERING. Smoke Prevention and Public Health. Vol. 19, 1900, p. 426. The wholesale poisoning of the air by coal products and the consequent obscuration of the sun and absorption of oxygen is a direct danger to every individual, and, if permitted to go far enough, would doubtless result in the final extinction of the human race. The influence of smoke upon public health is shown in the fact that there is no record of smoke-producing towns keeping up a natural increase in the population of cities being maintained at the expense of the country. It is agreed that a certain amount of smoke is not preventable. As the manufacturer will not realize economy by preventing production of smoke, any regulation of smoke will depend upon the degree to which the manufacturer is legally prevented from polluting the air. (USPHS)

816. HODGERTS, E. A. B. Smoke Abatement. Jour. San. Inst., vol. 21, 1906, p. 35. Claims that air pollution by coal smoke is a greater menace to public health than any other insanitary condition now existing and that the regions of greatest smoke production tend to become depopulated. Does not give remedies. (MIR—Bib.)

1907

817. GAUTIER, A. [The Smoke of Paris: the Influence of the Products of Combustion on the Urban Atmosphere.] Rev. d'Hyg., vol. 23, 1901, p. 97. An analysis made of air taken from the open street showed only one part in 5,000,000 of carbon monoxide, a proportion presumably inert in regard to health. It is believed, however, that the air near factories would contain enough of this gas to prove a menace to health. (USPHS)

1903

818. LUNGE, GEORGE. Injurious Action of Sulfurous Acid (Sulfur Dioxide). Theoretical and Practical Treatise on the Manufacture of Sulfuric Acid and Alkali. Vol. 1, 1903, pp. 154-159. Quotes authorities as to the extent to which sulfurous acid vapors are harmful to animal and vegetable life. (MIR—Bib.)

1905

819. MEHL, W. [Smoke and Soot; Their Effect on Health.] Gesundheit, Leipzig, vol. 30, 1905, p. 747. Concludes that "no one has yet shown that smoke and fog are injurious to health." Later demonstration using statistics indicates that the increased death rate from respiratory diseases in large industrial centers must be related to the influence of smoke and dust. (USPHS)

820. REED, C. A. L. The Smoke Question Viewed From a National Viewpoint. Am. Med., vol. 9, 1905, p. 703. Generalizations are made with regard to the effect of smoke on health. No substantiating evidence or statistics are included. Recommendations are made for smoke abatement on a national scale rather than on a local level. (USPHS)

1906

821. COPLIN, W. M. L. The Smoke Problem and Public Health. Jour. Am. Med. Assoc., vol. 47, 1906, p. 384. Regarding the influence of smoke on public health, the statistics are confusing and incomplete. There has been much disagreement among investigators on the influence of smoke on pulmonary structures, and there is little evidence to show that the presence of smoke in the air increased especially the morbidity or the mortality of a community. (USPHS)

822. FOX, L. W. Relation of Smoke-Laden Atmosphere to Disease of the Eye. Jour. Am. Med. Assoc., vol. 47, 1906, p. 384. An increase in the number of patients with external eye disease in the last 3 years is attributed to an increase of coal-dust-laden atmosphere due to the substitution of soft coal for hard. During this period more cases of conjunctivitis and pinkeye have been recorded than ever before in the history of the city. Worse than the smoke evil is sanding the city railway tracks, loading ash carts, and sweeping streets. Minute particles of crystal, ground to a powder, lodge in the eyes, nose, and lungs, resulting in various eye condi-
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1907


Within a few months following the discovery of natural gas in Pittsburgh, there was a decrease in incidence of disease of the upper air passages. (USPHS)


Although there can scarcely be any doubt of the possibility that the smoke content of the air is an important element of injury to health, the coincidence of bad air and disease is another matter. Such proof can scarcely be attained even by the standard of very exact etiological investigations. If there is an entire lack of knowledge as to how the pollution of the air by smoke is distributed in the country in general and as to whether the regions with impure air coincide to some extent with those of more frequent lung diseases, there is still further lack of proof as to whether the condition of the air alone is responsible for the injury, or whether remaining within doors does not also contribute to it. The injuries resulting from a pollution of air might also be traced to climatic influences. (USPHS)


All who are ill are made more susceptible to complications, and their recuperative powers are impaired, by a vitiated atmosphere. Laws governing the smoke problem should be more adequately enforced. (USPHS)

1907


With special reference to tuberculosis, the harmful effects of smoke and soot on the health of individuals are considered. The increase in mortality due to acute pulmonary disease was greater in industrial than in agricultural districts. In the course of 25 years, this increase amounted to 100 percent of infants, and in these districts the increase was most pronounced in those areas having a greater production of smoke.


Deals mainly with mortality from acute pulmonary diseases other than tuberculosis. (MIR—Bib.)


Some of the literature is summarized briefly. States that the idea should be dropped that the smoke question is only social and not medical. If that were so the natural sciences would have little to do with it, and not even the law of the land or of esthetics could ever reach it.


Presents general résumé of various constituents of smoke and their effects upon health.

It is not the dust only that is injurious, but it is the invisible products of combustion escaping from the chimney in the form of gases that need to be taken into consideration, such as carbonic acid, nitrogen, carbon dioxide, carbon monoxide, sulfur trioxide, sulfur dioxide, and sulfuric acid, and other heavy gases. Carbonic acid and nitrogen can probably be regarded as injurious only when they are driven directly into dwellings, and this cannot happen unless the chimneys are not high enough. The carbonic acid, which is extremely poisonous, is usually present in such slight quantities that it becomes greatly diffused as soon as it escapes from the chimney. On account of its lightness, it rises rapidly and is lost in the higher strata of air; but the gaseous sulfuric acid (sulfur dioxide), which is considerably heavier than air, is such an injurious gas that first of all efforts must be directed toward preventing it from doing harm, as not only humans are injured but vegetation, soil, and buildings are destroyed. These facts show that any smokeless furnace with a direct combustion has little value for the public as far as the purification of the air is concerned, unless the dust and the sulfuric acid are retained at the same time.

1907


The smoke problem is one of esthetics, discomfort, pecuniary loss, and public health. A large part of London is now unfit for human habitation. The air contaminants are obvious and to a certain extent poisonous. It has been proved that sulfuric gases, hydrocarbons, and carbon dust have an adverse effect on respiratory organs. It is not surprising, then, that bronchitis, pneumonia, and kindred complaints are very common. Tuberculosis is doubtless largely intensified by inhalation of the smoke-laden air. Loss of health also occurs because of reduced sunshine. In the vicinity of large towns, crops, trees, and vegetation in general suffer, and each year it is increasingly difficult to grow trees, roses, and other plants. The annual saving through more complete and intelligent combustion of coal, with reduction in smoke, is discussed. (USPHS)

1908


For the 10 years before 1907 the noxious effect of sulfur was studied, and it was concluded that it is one of the most patent causes of asthma. It is estimated that for every ton of coal burned, 3 tons of sulfur dioxide are formed. Sulfurous acid is formed from sulfur dioxide, and this is very detrimental to buildings and vegetation. During periods of heavy fog in manufacturing centers, the morbidity and mortality from respiratory diseases are increased greatly, and as the atmosphere clears, a sharp decline follows. Sulfur dioxide is a local irritant producing coughing, bronchitis and pneumonia. Kishina discovered, in his experiments with sulfur dioxide in rabbits, that the pulmonary capillaries were seriously damaged and the blood itself underwent chemical changes. He believes that sulfur dioxide is a protoplasmic poison. He observed that long-continued, small doses affected the lungs seriously. Sulfur dioxide inhaled by some people will produce or bring on attacks of asthma.

1908


Considers physiological effect of smoke and impurities in air. (MIR—Bib.)


Physiological effects of vitiated air, considering coal smoke briefly. (MIR—Bib.)


Includes discussion of the detrimental effects on health caused by smoke and its constituents. (USPHS)
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1909


This exhaustive study of the effect of smoke upon health of firemen reveals the following symptoms from inhalation of soot: (1) Redness and congestion of conjunctiva, tears; (2) inflammation of nasal mucous membrane and frontal headaches; (3) enlarged tonsils and redness and congestion of pharynx; (4) inflammation and edema of larynx, dry painful cough, asthmatic symptoms; and (5) bronchial or lobar pneumonia.

From work on animals, it is concluded that carbon particles play a large role in the production of serious symptoms. The action of carbon particles on the mucous membrane. Animals exposed to filtered smoke (with soot) recover more easily than those exposed to smoke not so filtered. (USPHS)

1910


Discusses the smoke problem in relation to health. (MIR—Bib.)

837. GODFREY, HOLLIS. Air; chap in Health of the City, Houghton Mifflin Co., 1910, pp. 1-29.

Chapter dealing with air from sanitary and hygienic viewpoint. Touches briefly on injurious effects of smoke and outlook for abatement. (MIR—Bib.)

1911


The most important atmospheric considerations in relation to health are stated to be (1) chemical composition of atmosphere, (2) solids floating in air, (3) moisture and extreme temperatures, (4) degree of humidity, (5) slight disorder from due to the action of carbon particles on the mucous membrane. Animals exposed to filtered smoke (with soot) recover more easily than those exposed to smoke not so filtered. (USPHS)

With ordinary ranges of humidity and temperature, the nasal mucous membrane completely saturates the air with aqueous vapor. In cold and dry mountain climates, there is a very free nasal secretion—more than good enough to saturate the air—while at low levels the reverse is true, the nose becoming "stuffly." The mechanism on which this depends is found in the erectile tissue, and anything favoring the engorgement of veins, such as weak heart action, chronic bronchitis, or kidney disease, leads to a corresponding turgidity of the nose and sinuses. In addition to barometric and other influences, it has been found that light produces collapse of this tissue, smoke having a similar effect. This latter effect probably accounts for the fact that many asthmatics are better off in a city like London than elsewhere, since the smoke relieves the turgescence of the inferior turbinate of the nose. (USPHS)


Deals mainly with conditions in that city. Partly statistical. Claims that "both directly and indirectly, smoke causes serious injury to health, especially during November, December, and January. This injury is manifested in an increased respiratory mortality." (MIR—Bib.)

1912


Contaminating factors of smoke include carbon soot, least harmful to health; fly ash blamed for high incidence of tuberculosis, upper respiratory infection, chronic sinusitis, and silicosis; fine gases, sulfur dioxide, and others that are noxious and perhaps carcinogenic; and steam, smoke, and soot. It is recommended that the use of high-volatile coal in the city be avoided unless it can be properly burned, steps be taken to decrease fly ash, and use of non-condensation steam engines be eliminated. (USPHS)


Some of the industrial conditions that are prejudicial to health are considered. Statistics on industrial accidents and deaths are cited. On the effect of smoke on lung diseases, the conclusion is drawn that a smoke-polluted atmosphere predisposes to acute lung diseases and hastens the course of tuberculosis. Dust from tarred roads is accused of (1) damaging foliage by blocking stomata and thereby causing stunted vegetation, (2) killing trout in streams, (3) reducing the number of birds because insects are scarcer, and (4) increasing lung disease, particularly tuberculosis, among street sweepers. The social influence of air impurities, such as increased filth and grime, is discussed. Other aspects considered are explosions in mines and industrial dusts. (USPHS)

1913


It has been proved by the best mechanical engineers and Government bureaus that emission of black smoke means waste of fuel. Many men who have been compelled to make proper installations for smoke abatement say that such improvements have been big dividends from the beginning. In fact, the loss to the producer of the smoke nuisance forms the largest single item in our budget. This in Pittsburgh amounts to nearly $4,000,000 per year.

Smoke is detrimental to health. Following the weekly course of mortality, one cannot fail to be struck with the manner in which the mortality from many respiratory diseases increases after a fog. The large amounts of soot (in one case, 10 grams, equivalent to about 3/4 of a pint) found in the lungs of dwellers in a smoky city cannot but be detrimental, at least to some extent, to the execution of their normal function. Within the corporate limit of the city of Pittsburgh, in those sections of the city where the smoke cloud hangs heaviest, the death rate from pneumonia is the greatest. Singers visiting Pittsburgh get the Pittsburgh sore throat. In fact, much of our throat trouble is caused by the smoke and dust in the atmosphere. This is a subject to be taken into consideration in connection with city sanitation.

Abolition of the smoke nuisance, therefore, unlike many other social evils against which an outcry has been made, will result in direct and immediate gain both to the public at large and to those chiefly responsible for the nuisance itself.

843. COAL AND CORE OPERATOR. Atmospheric Pollution from Coal to Destroy Animal Life. Vol. 16, 1913, pp. 223-224.

Outlines theory of Prof. Ludwig Pritch of Germany, who "discovered the imminent fact that carbon dioxide is responsible for the death of a per cent, closely approaching the fatal poisoning proportion." Recommends closing coal mines for a period of years, and fears that with increasing carbon dioxide content of the atmosphere, by the year 1950 the human race and animal life in general will not be able to survive the toxic effect. (MIR—Bib.)


Discusses the microscopic effects of smoke and soot as observed upon the air passages and lungs and the
association of the resultant pulmonary lesion with those of tuberculosis and pneumonia. Some of the conclusions were as follows: With regard to tuberculosis, the obliterating of the pulmonary lymph spaces in the anthracotic process is unfavorable for the local spread of tuberculosis and aids in the localization of the condition. With regard to acute inflammatory conditions where the lymphatics are important for proper resolution, anthracosis becomes seriously detrimental, because of the obliteration of those spaces. (USPHS)


Sulfur dioxide is a colorless, pungently smelling gas, which, acting in low concentrations or for a short period, causes cough and irritation of the mucous membrane of the respiratory passages and of the eyes; acting for a longer period, it sets up inflammation of the mucous membrane, bronchial catarrh, expectoration of blood, and inflammation of the lungs. A proportion of 0.03 to 0.04 per 1,000 of sulfur dioxide in the air has a serious effect on a person unaccustomed to it. (USPHS)


Much of the discussion on health is from the psychological point of view and centers around the depressing effect of smoke on the quality of life. Because poor people cannot get out into the country air, there is a higher percentage of pulmonary diseases among them than among those who live in or have a vacation in the country. "Statistics show that there are more people subject to nasal, throat, and bronchial troubles in a smoky city than in a comparatively clean town. There are also more fatalities from pneumonia, diphtheria, and typhoid fever owing to the lowering of vital forces as a result of scarcity of sunshine caused by heavy fogs of smoke." (USPHS)


The pathology of smoke: Principal portal of entry for soluble inhaled particles is reportedly via the alimentary canal rather than respiratory tract. An increased morbidity and mortality from tuberculosis and pneumonia are cited for a high incidence of a feeling of depression in people living in smoky industrial areas. Smoke produces meteorological variations, which further affect the well-being; for example, loss of sunshine, increasing humidity and fog, increasing intensity and duration of fog, decreasing visibility, and higher temperature. Pathological effects include a decrease of erythrocyte count and a decrease of hemoglobin. There is considerable discussion of the various mental effects of darkness and gloom as compared with light and sunshine. (30 refs. cited) (USPHS)

1914


Attempts to cul from scientific literature the evidence, preliminary and conclusive, concerning the role played by a smoke-laden atmosphere in community health.

Results of analyses of vital statistics, special investigations, and experimentations bearing upon the relation of smoke to health are presented. (49 refs. cited)


"The weight of evidence concerning the relation of this gas (sulfur dioxide) to health indicates that its effects are neither serious nor lasting, and are exerted more on the digestive than on the respiratory function. In some individuals, a small amount in the atmosphere causes epigastric pain and heartburn very quickly." (USPHS)


The histological evidences as to the disease importance of anthracosis of the lungs are the results of studies to determine whether or not intensive deposits of dust and coal pigment within body tissues have or have not any "real disease" significance. Under certain conditions moderate anthracosis is not in itself detrimental, under other conditions it may be seriously detrimental. (8 refs. cited)


In a brief summary of previous work on related subjects it is pointed out that views and conclusions varied widely as to the effects of smoke or soot on microorganisms. Microorganisms were said by some to be increased in the air in the presence of smoke, whereas other workers held the opposite view. In this investigation the author reported on the results of observations on the growth of bacteria in two culture media, one of which was exposed to soot. The medium containing soot showed a definitely smaller growth than that not exposed to soot. General conclusions were that soot is definitely bactericidal and that this action is due not only to the acids contained in soot but also to some other agents, probably some of the pneumoconiosis. It was also concluded that soot bars the destructive action of sunlight on microorganisms. (USPHS)


Pulmonary anthracosis (not in coal miners) is distinctly an urban disease and is proportionate to the smoke content of the air. This conclusion was reached after a study of the literature and observations on a series of autopsies. (54 refs. cited)


A paper presented at a smoke-abatement conference in London. The incidence of cancer was found to be limited to regions where coal was the stable fuel, whereas where wood was used, cancer was almost nonexistent. It was pointed out that if these results were confirmed they would form a terrible indictment of coal as an ordinary fuel.


Leeds University asked Yorkshire farmers whether livestock is likely to suffer when living in the neighborhood of railroad yards, industrial plants, and large manufacturing centers. The answers showed that not only animals but also grass and other plants suffer. The growth of young stock is kept under such conditions, and old stock or horses require much more care and food than those that live in a pure air. Such effects on animals are due partly to the direct action of the vitiated air when taken into the lungs and partly to the very poor quality of the grass that grows, as it cannot develop under good conditions. Sheep raising is especially difficult in these places, sometimes even impossible. Near Leeds, it had to be discontinued for the wool was of very poor quality and full of impurities of various kinds. Thus it appears that the same general rules apply to animals as to human beings under similar circumstances.
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For this study, pneumonia was the criterion for an acute lung infection and tuberculosis for a chronic lung infection. In addition to smoke, other factors that may contribute to the drawing of any conclusions are discussed. The various large cities in the United States where the study was undertaken, the number of years that the city had been incorporated and flatness of city contour were considered. Cities were plotted in decreasing order of smoke for years 1908–12 among those that revealed the highest attacks of pneumonia and tuberculosis. Pneumonia showed a higher incidence in the smokier cities. On the other hand, mortality from tuberculosis increased as the number of smoky days decreased. No statistics were given to indicate whether the difference was significant. There were some exceptions to the above deductions in some cities. (USPHS)

1915


After questioning and testing individuals with various concentrations of sulfur dioxide ranging from 1 part per million up to 24, it was found that the average individual familiar with sulfur dioxide odor could detect its presence in 3–3.5 parts per million and one not familiar with the odor, in 4–5 parts per million. It was pointed out that chemists' opinions as to what concentration constitutes a nuisance vary widely, ranging from 3 parts per million to over 20 parts per million. Further, physiological effects were not manifest below 5 parts per million. Most individuals experienced throat irritation and coughing at 10 parts per million. As concentration increased, the throat and chest irritation became more acute. Five hundred parts per million caused a sensation of suffocation. Nausea appeared with concentrations higher than 50 parts per million.

To determine the effect of sulfur dioxide on man, experimentation was carried on using 60 subjects divided into two groups—those familiar and those not familiar with the odor of sulfur dioxide. Veterinary studies on lambs exposed to the smoke and sulfur dioxide revealed a high incidence, or over 8.5 percent, of roarrers in a survey of all horses in the smoke zone near the smelter stacks at Selby. (USPHS)

1918


Emphasizes the need to assess the value of oxygen in the air before the effects of carbon dioxide can be adequately appraised, since death or toxic effects may be due as much to a decrease in oxygen as to the increase in carbon dioxide. Other factors that also must be considered are physical factors, temperature and humidity, and presence of other toxic gases. From a review of the efforts of other workers, it is concluded that the safe limit of carbon dioxide in the working atmosphere is 0.2 percent. (USPHS)

1919


Most irritant gases cause an inflammatory edema followed by a cellular exudate both in upper air passages and in lung parenchyma. The highest mortality with high concentrations occurs in the acute, edematous stage with a second peak in the pulmonary process. Particular consideration is accorded the effects of the war gases—mustard, chlorine, and phosgene—which have an initial necrotizing action. (USPHS)

1921


Smoke is extremely irritating to the eyes and throat and may interfere with breathing enough to produce unconsciousness. When inhalation of sulfur dioxide is prolonged, or the concentration is very high, death may result from respiratory spasm and asphyxia. "Ordinarily, however, exposure to mild fumes merely produces headache, coughing, smarting of the eyes, and later constriction of the chest and bronchitis." The effects of other gases, such as carbon dioxide, carbon monoxide, ammonia, illuminating gas, and chlorine, are also discussed. (USPHS)

1923


The health hazards of soot and sulfur dioxide are dealt with in detail. Psychological factors are discussed also.

1923


Sulfuric acid mist irritates the exposed mucous membranes as well as the thin epidermis on the face and back of hands. A person gassed by an irritating gas complains of difficulty of inspiration, shallow inspiration with coughing spells, external dyspnea, palpitation, dryness and burning of the throat, throbbing at the temples, and nausea and vomiting. (USPHS)

1924


Smoke is designated as a health question, almost a health menace. Refers to the great strides in purifying water and safeguarding foodstuffs but little is being done toward the purification of what we must have all the time, asleep or awake, and that is air.

The effects of breathing the products of combustion are mechanical and chemical. Carbon is a mechanical irritant and is said to superinduce tuberculosis of the lungs. Smoke also plays a part over a city, which filters out not the luminous portion but the chemical portion of the sun's rays. This makes three points to consider: The obstruction of the sun's rays owing to smoke, and it does not take dense smoke to do that; the mechanical irritants to the respiratory tract; and the chemical irritant or chemical poisoning.

There is no proof that the smoke kills people outright and promptly, but it does produce injury, and leading authorities say that it superinduces a condition to tuberculosis. The subject of smoke prevention should be considered as seriously in proportion to its importance as the problem of water and milk purification with a view of safeguarding the health of the human race.

1924


"Fundamentally, the toxicology of all irritants is the same; the differences in symptomatology are chiefly the results of differences in the location of their action." An irritant gas causes inflammation of those tissues it contacts. Moist tissues, chiefly the mucous membranes of the respiratory tract and conjunctiva, are most easily affected and most affected. The reaction is physiological, not merely a direct chemical effect. Reflexes are brought into play to protect the different parts of the respiratory tract.

A table gives the relation between the physical properties of irritants and their site of action in the
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respiratory tract and subsequent symptomatology.

(USPHS)


Lignite tar, gasworks tar, producer-gas tar, and coke-oven tar have been found experimentally to produce cancer in mice and rats, whereas blast-furnace tar does not. (USPHS)

1925


General comments on air pollution in Pittsburgh are discussed, including a statement of the problem, the Mellon Institute study, the Ringemann chart, and general results to date of legislation enacted against smoke. The author feels too much stress is placed on solid particles and not enough on abatement of the noxious gases.

Evil effects of polluted city air are thought to be irritation of the membranes of the eyes, nose, throat, lungs, and gastrointestinal tract; diminished potential reserve, working capacity and well-being of individuals; increased fatigue, irritability and malcontent; and hastened premature decay. Smoke and other impurities have an important bearing on the pneumonia death rate but a comparatively little effect on the tuberculosis death rate. Smoke reduces the intensity and duration of sunshine, reducing in reduced visibility; it also increases humidity, mists, frequency and duration of fogs, and possibly alters the electric potential. The bactericidal and vitalizing influence of sunshine on man are thereby reduced. Anemia, transpiration and percentage of hemoglobin are also affected by the reduction or loss of sunshine. Dark clouds also have a depressing, desensitizing effect. Increased humidity increases exposure to suspended noxious gases. (USPHS)

1926


Carbon monoxide poisoning is closely related to the history of mankind. Carbon monoxide is so dangerous because it is colorless, tasteless, and virtually odorless. The weight of opinion favors carbon monoxide as causing anoxemia, which, in turn, causes death. Clinical symptoms, both acute and chronic, are reviewed. Individual idiosyncrasy will determine whether the victim will receive permanent damage from carbon monoxide or none at all. Tolerance or immunity to carbon monoxide will protect some from large amounts of the gas, yet others will be overcome by the same amount of carbon monoxide gas.

Effects of the gas have been noted by traffic officers on busy Chicago street corners. All writers appear to agree that slow, gradual gassing is far more serious to a man than to be suddenly exposed to a high concentration. Gasoline-engine exhaust contains from 2 to 3 percent carbon monoxide. Carbon monoxide density is virtually the same as air density. The composition of exhaust gas is tabulated. Carbon monoxide from car exhaust lies in a layer about 5 to 15 feet above the street, and the concentration depends upon atmospheric conditions. On damp, still days the carbon monoxide content of the street mounts during heavy traffic to a point where a distinct health menace is created. Some writers accredit some accidents to the mental dullness of drivers due to carbon monoxide. Headache, dizziness, and reduced vision and coordination are common complaints of motorists in a slow-moving line of traffic. Traffic police report fatigue, dryness in the throat, headaches, and bronchial irritation after directing traffic at a busy intersection. (USPHS)


Deep breathing in polluted atmospheres is shown to be harmful by dust counts on inspired and expired air under various conditions of breathing. (USPHS)


Smoke is said to affect health directly by its ill effects on the organs of respiration and indirectly by diminishing the amount of sunshine and cutting out a considerable proportion of the ultraviolet rays. The direct effect of smoke on respiratory diseases. Many cases of rickets and tuberculosis are said to be caused by smoke. There is also a close relationship between pulmonary and cardiac diseases and smogs. The cause underlying the high mortality in towns, which is known to follow in the wake of a fog, must operate continuously, though in a lesser degree, on the health of an urban community. Smokeless fuel is discussed at length. (USPHS)


The work to date on effects of smoke on health is reviewed, and the contention is that the evidence is indicative but not conclusive that smoke is damaging to health. A plan is proposed for further investigation. It is felt that the important components of smoke with regard to health are carbon and other dusts. (USPHS)


Policemen at heavily traveled intersections in Philadelphia complained of symptoms of carbon monoxide poisoning, such as headache, slight nausea, and muscular weakness. Tests for carbon monoxide-hemoglobin concentrations made of the officers stationed throughout the city, showed decidedly abnormally high levels. It was concluded that “the existence of a definite street risk of repeated or chronic slight carbon monoxide anoxemia is confirmed. Confirmation of such a diagnosis should be sought for by testing the blood for carbon monoxide.” (USPHS)

1927


The physiological effects of smoke are reviewed. Experiments carried out in Pittsburgh seemed to indicate that the breathing of smoke-laden air has no demonstrable influence on the prevalence of tuberculosis but has a definite relation to the high pneumonia mortality and the incidence of acute respiratory diseases. (USPHS)

1928


The current knowledge regarding smoke pollution and its effects is summarized. A review of the literature leads to the conclusion that it is indeed difficult to show the influence that atmospheric smoke exerts on public health. Smoke is defined as the mixture of fine gases and suspended particles of solid or liquid matter that is produced by certain fuels during combustion. The direct effects of smoke are difficult to assess. It is difficult to prove a direct relation between smoke pollution and the death rate. Too many other factors are
present that could contribute. Smoke indirectly affects health through reduction in sunlight. This loss affects even more the health of the poor. It is concluded that smoke is but one of the possible factors contributing to the death rate of cities. (USPHS)


The noxious gases in smoke are important enough to health to warrant more consideration to their control.

Concentrations of some gases are given, and their general effects on health are discussed. (USPHS)

1929


The harmful effects of air pollution are enumerated; Pulmonary disease, rickets, diminished farm crop yield, poorer quality of all farm products, toxic effects on plants, and deterioration of buildings. The indifference of the populace and officials to the problem is stressed. Governmental action on a national scale throughout England is urged. Improvements for industrial and domestic heating equipment for old and new establishments as well as curtailed use of smokeless fuels are suggested. (USPHS)


The pollution of the atmosphere with smoke produces, which in turn has a psychological effect upon the people. Sunlight is necessary for both mental and physical health. The tar, acids, and carbon of smoke damage the lungs as well as produce cancer.

England has a Smoke Abatement Law with rigid enforcement and severe penalties for violators. (USPHS)


The damage to which we may lay much of the smoke of today lays a responsibility to change. Smoke indirectly kills and maims: (1) It interferes with the breathing apparatus causing diseases of the lungs; (2) It interferes with sunlight and promotes rickets; and (3) it depresses.


Dust and smoke, especially coal and quartz,-which produce an anthracosis and chalcosis of the lung with resulting chronic interstitial pneumonia and chronic bronchitis with secondary regenerative metaplastic changes and proliferations of the bronchial mucosa and alveolar epithelium, are considered by many as etiologically important factors and are regarded by them as causative agents that are responsible for the recent marked increase in frequency of lung tumors. Others do not believe that smoke and dust are factors in increased incidence of lung cancer. Inhalation of vapors of acids and alkalies is suggested as the possible causative agent in lung cancer. (USPHS)


Cattle pastured along the bank of the river Leine in the suburbs of Hannover were attacked by severe lameness and if allowed to remain in the pastures began to appear emaciated, showed rough, bristly hair, and a decline in milk production. Also, severe injury to vegetation appeared. The window panes of the houses in direct line of the smoke from neighboring factory became cloudy.


Health is the most important factor in connection with smoke prevention, because without health we cannot carry on business or cultural enterprises, nor can we exist without good health.

Smoke hinders aviation—we have yet to figure out how to move a cloud of smoke from a community to allow a ship to land. The only solution to smoke abatement is education of the general public.


In the matter of carbon monoxide pollution of the air, virtually every city dweller suffers from some degree of chronic anemia from this cause. It is stated that it is rare to find a city dweller who does not have some degree of anemia. (USPHS)

1930


Depth and rate of breathing increase with percentages of carbon dioxide and normal oxygen. Soreness in "region of the diaphragm," fatigue, mild headache, and chilly sensation result after exposure to these levels of carbon dioxide. (USPHS)


The human element is a very important factor, and the ability of the fireman to maintain desired steam pressure, take care of his many duties, and keep a comparatively clear deck is one of the problems. Most railroad men are agreed that smoke is objectionable from the standpoint of cleanliness; they are still unconvinced that it is a menace to health.


The solid particles of soot that lodge in the lungs pave the way for such respiratory diseases as pneumonia and tuberculosis. Municipal authorities must be on guard not only against smoke but against more dangerous air pollutants such as noxious and poisonous fumes that result from certain industrial processes.


There is a variation of cancer deaths in different countries. Green’s work in England and Scotland seems to point to a distinct influence of topography and of fuel combustion products on cancer death rates. Other data indicate the influence of smoke and fumes or tar on cancer. (USPHS)


The impurities in the atmosphere in Manchester amount to 20,000 tons of solid matter, 75,000 tons of tar, and 250,000 tons of acids per year. The result of breathing air so badly polluted on the lungs is chronic irritation of the bronchi, a susceptibility to bacterial infection, deposition of soot in the lung tissue with resulting catarrh, bronchitis, emphysema, and cardiac failure.

After a fog in which atmospheric contaminants are concentrated in the lower layers of the atmosphere, there is considerable increase in the death rate from respiratory diseases. (USPHS)

1931


Autopsies performed on cows that died in the Belgian (Meuse Valley) fog showed that they had died from
pulmonary edema. Highly efficient nuclei from the production of fog were furnished by dust particles in the air and their nature of infection. The newspaper reports indicate that the persons and animals were attacked suddenly with symptoms that, because of their abruptness and nature, led one to suspect that there were the nature of anaphylactic phenomena. The time of exposure before severe illness was too short to suggest bacterial infection. "Thus, for example, it might be possible that castor bean cake containing the poisonous protein ricin had been used as a fertilizer in that neighborhood and that some men and animals had become sensitized to it. The fog, settling, might have brought into the lungs of these sensitized beings enough ricin dust to occasion the onset of anaphylaxis. (USPHS)


Certain symptoms common to all were painful irritation often mounting to an active retrosternal pain and extending along the outer edge of the ribs; attacks of coughing, dyspnea, often paroxysmal; and prolonged expiration. Adrenalin often gave relief. They were obviously affected with asthma or heart disease developed symptoms of shock. In addition to the tracheobronchial pulmonary irritation, a large number showed signs of general irritation causing cough and modulation of the tone. The urine also showed some nausea and vomiting, lacrimation, and tenacious sputum. In one case there was desquamation of the mucosa of the entire buccal cavity. There was no diarrhea, urinits, albuminuria, hematuria, or septic disorders. There is no reason to believe that only the III and the aged were seriously affected by toxic attacks." Persons were attacked who had not left their houses for several weeks or who had not gone out in the fog. At autopsy there was congestion of the mucous membranes of the air passages. All the symptoms and all the lesions found could be sufficiently explained by a local irritation of the exposed mucous membranes. (USPHS)


The most important atmospheric pollution at present is due to smoke and soot discharged from household and industrial chimneys in many large cities. In addition to the suspended carbon, dust, and ash particles, the exhalations are charged with unconsolidated hydrocarbon gases, sulfur dioxide gas, and other industrial products of combustion, and health. Aside from specific industrial processes that produce harmful dusts and fumes, the consensus is that most of the mischief attributed to general atmospheric pollution is fictitious and generally indirect. The objection is considered to be largely economic.

Dust may affect health in two ways: (a) By inhalation and (b) by obliteration of the sun's rays. Although these facts are well recognized, there is no proof that the dust in ordinary air is effective enough to cause demonstrable injury to health. The effects may be slow, cumulative, and insidious in their manifestations, but for the time being direct evidence is lacking.

Dustborne bacteria are sometimes held responsible for the transmission of disease microbes through the medium of air, but the epidemiological evidence weighs on the negative side. Bacteria of the pathogen variety are found to constitute but a very small proportion of the total dustborne bacteria. The nonpathogenic bacteria in air are, in general, considered harmless, but it is not known whether the constant inhalation of these organisms may eventually produce harmful effects.

In the light of our meager knowledge of the effects of atmospheric pollution on health, it is fair to say that any conspicuous air pollution constitutes a liability to property and health, and that steps should be taken to reduce pollution to a minimum. This would require the concerted efforts of the engineer, the public health officer, and the public itself.


The source, contents, and health implications of atmospheric pollution are discussed. The effects are considered as direct and indirect. Direct effects are due to the inhalation of contaminated air. The solid particles that are inhaled can irritate the sensitive mucous membranes of the respiratory tract. Indirect effects are due to the shutting out of sunshine, particularly the shorter wave lengths. This loss, coupled with increased incidence of smog, dark clouds, and mists, leads to a psychologically depressed mental state. (USPHS)


Review of literature on air pollution and its effect on health is included. Substances that pollute the air are discussed in some detail with emphasis on sulfur. Also mentioned are arsenic, chlorine, and oxides of nitrogen. Instruments and methods for investigating air pollution are mentioned.

Effects on general health include loss of adequate sunshine and the depressing effect of clouds and fog. A marked decrease in ultraviolet rays from the sun is postulated as a large factor in the incidence of rickets, tuberculosis, anemia, and infections in general. An analysis is made of sunlight lost and reasons for this loss, which include the season, humidity, clouds, and velocity of the wind. The high incidence of respiratory diseases in England is cited, as in the correlation of decreased mortality in one town in which a prolonged coal strike reduced smoke. Present legislation usually deals with visible smoke without requiring dissipation of invisible noxious substances. Irritation of the eyes, particularly by carbon particles, leads to increased incidence of conjunctivitis. The inferiority of artificial light to sunlight for vision is stressed. Vegetation is injured by air pollution. There is an increased morbidity and mortality to tuberculosis in polluted areas. (USPHS)


After 3 days of fog in the Mense Valley, a large number of people complained of irritations in the nose, mouth, throat, trachea, and bronchi. The mucous membranes were red and swollen. Necroses later revealed that these inflammations reached down into the bronchi. In the serious cases dyspnea, dilatation of the heart, rapid pulse, and cyanosis developed. Signs of pneumonia were not present. Epinephrin brought temporary relief. Among those ill and those who died were persons with asthma, bronchitis, and heart disease. However, previously healthy young persons also became ill. The 63 fatalities all occurred within 24 hours in the narrow valley south of Liege. The author believes lack of oxygen was not responsible. More important as a cause are the toxic irritative gases emitted by the industrial plants in the area. These include sulfur dioxide and hydrofluoric acid. (USPHS) 1932


Some of the arguments presented for increased smoke abatement are as follows: The lungs of urban dwellers are thickened as are those of the coal miner. The tarry and sulfuric acids set up irritation and play no small
part in causation of chronic catarrh, bronchitis, and tuberculosis. By reducing sunshine, smoke indirectly increases incidence of rickets as well as causes a general lowering of vitality. Atmospheric impurities have a large measure of direct responsibility for pulmonary diseases. (USPHS)


The purpose of this study was to substantiate or re-udiate the claims made about exposure to sulfur dioxide. These ranged from marked toxicity to the belief that exposure is beneficial to health. The study involved workers at an electric-refrigerator-manufacturing plant, where there were ideal conditions of known exposure in some workers and nonexposure in others doing comparable tasks. One hundred exposed and one hundred nonexposed workers were chosen for complete histories and physical examinations. The control group closely approximated the exposed group as to age, weight, height, blood pressure, erythrocyte count, hemoglobin percentage, and white blood cell count. None of the particles and considered air counts were higher in the control group and the lymphocytes were higher in exposed groups. The differences were statistically significant. Physical finding differences statistically significant are tabulated and included slight and chronic pharyngitis, urine acid to methyl red, slight chronic tonsillitis, and abnormal reflexes. Acclimatization is also discussed. Chest X-ray studies also revealed statistically significant differences. Symptomatology was principally confined to the respiratory tract, except that statistically significant differences were noted for shortness of breath on exertion, increased fatigability, altered sense of taste or smell, and increased sensitivity to other irritants. (USPHS)


Many phases of the Meuse Valley incident, including a section on the medical findings, are covered. It appears that most of the ill persons were elderly and included a large number of asthmatics and cardiac. There was some illness among healthy adults and children. Deaths were generally ascribed to cardiac failure. Autopsies showed a diffused congestion of trachea and large bronchi. Soot particles were observed free in the pulmonary alveoli.

A section discusses the possible causative agent in the episode and the conclusion reached is that it was most likely compounds of sulfur, especially sulfur dioxide. (USPHS)


Cancer is said to be caused by the continuous mechanical and chemical irritation of poisonous agents, spread over a length of time, combined with light starvation. They differed in that the polyaminiccinogentic. Not only respiratory but also uterine, breast, scrotal, and other forms of cancer may be caused by soot. (USPHS)


Gases emanating from zinc and lead foundries in the district of Katowice have been detrimental to the small nearby farms. These foundry gases are composed of particles of ore, coal dust, lead, zinc, sulfur dioxide, carbon dioxide, carbon monoxide, and possibly hydrogen sulfide and arsine. Because there is a limited demand for sulfuric acid, sulfur dioxide is dissolved into the air.

Toxic effects of sulfur dioxide on man are described. Low concentrations cause "coughing and symptoms of scratchy mucous membranes of the respiratory passages. High concentrations damage mucous membranes and cause catarrh or bronchitis, possibly hemorrage, and finally inflammation of the lungs." There is apparently no effect on the blood. A permanent worker is not affected in a sulfur dioxide atmosphere, whereas a new man may feel ill.

Study was undertaken "to determine how sulfur dioxide is diluted in the atmosphere, and at what radius from the center of production it settled and can act injuriously on people." The manner of carrying out research is described. It was found that wind of uniform velocity (2 meters/second) does not appreciably dilute the sulfur dioxide.

Data are given for many sampling points: Distance from the source of sulfur dioxide, concentration of sulfur dioxide, temperature, humidity, wind direction, and concentration of sulfur dioxide found at that point. Rain never favored the disposal of the gases because the concentration was higher in rain than during good weather. The levels of sulfur dioxide obtained for Silesia were more damaging than those for Pittsburgh.

In fine weather, the sulfur dioxide content for the locality immediately about these foundries was lower than when there was a heavy fog, a low overcast, or rain. Wind played an important role in distributing the gases. Weak winds and calm appeared to disperse the gases much better than strong winds. Sulfur trioxide, hydrogen sulfide, and hydrogen fluoride were found in the chimney gases but not in toxic amounts. (USPHS)


This is one of the earliest reports against the growing smoke nuisance of London, discussing its effects on buildings, gardens, and health and giving recommendations for its abatement. The author recognizes that in the past almost every family carried in their houses smoke and that this was good for health. He then concludes that it is to be considered how much longer one would live in a cleaner atmosphere. The effect of smoke on the respiratory tract is emphasized by describing the incessant "barking, spitting, coughing, and snuffing" in the churches and other assembles of people. The consequence of this polluted air is that almost half of the deaths in London are the result of "putridal and pulmonary distempers." The inhabitants of London are not free from "coughs and importunate rheumatics, spitting of impostumated and corrupt matter." Members of the College of Physicians consider the smoke a "preservation against infections" although the "more learned" among them renounce this opinion. The contaminants in smoke responsible for much of the effects are reported to be sulfur and arsenic fumes. (USPHS)


Because no indisputable bad health effects can be assessed to air pollution (particularly by foul, odorous material), it was thought that steps toward correction might be taken on the basis of the repugnateness of the odor. This odor leads to digestive and other disorders. The wide individual variation in susceptibility to odors is discussed. This investigation covers: (1) Origin and cause of odors, (2) degree of magnitude of the odor, and (3) effect, if any, of odors on health. The effects of odor were tabulated according to the complainants'

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symptoms, which included throat irritation, headache, nausea, and suffocation. The illness of 96 people was attributed directly to pollution by refining of high-sulfur petroleum. The 96 cases are broken down as follows: 89 said that their illness was caused or aggravated by the odors and 7 cases were reported by physicians as illnesses caused or aggravated by the odors. (USPHS)


This article discusses factors in the atmosphere that may be connected with the incidence of lobar pneumonia during childhood. Such considerations as temperature, humidity, air movements, and seasons are discussed. Neither smoke nor atmospheric pollution is taken into account as factors. (USPHS)


It is not possible to recognize definitely any acute mental disorders or specific disability, yet the process of slow smoke poisoning may work insidiously on the vital tissues, making it impossible for the brain to function at maximum efficiency. (USPHS)


The cases of poisoning in the Meuse Valley in December 1930 were due to formation of fog loaded with the waste gases of numerous factories, chiefly sulfur dioxide and hydrofluoric acid. According to Fenner the poisoning effect was caused by the fluorine silicate or fluorosilicic acid in the factory gases. (USPHS)

1934


The experiments showing the carcinogenic effect of tar suggests the carcinogenic effect of a smoke-laden atmosphere. The increased incidence of lung cancer is cited. Rickets and tuberculosis show an increased incidence where sunlight is diminished by a smoke-laden atmosphere. Methods of smoke concentration, detection, and recommendations for control are discussed. (USPHS)


Particular reference is made to asthma in children. Nonspecific causes such as eating, heat, humidity, and extreme cold could not be considered fundamental causes, but rather excitatory, precipitating an attack in an individual with an asthmatic predisposition or an asthmatic history. On clinical grounds, sulfur dioxide may be specific precipitating cause of asthma. (USPHS)

904. GERIN, C. [Experimental Contribution to the Chemical and Physiological Investigation of Sulfur Dioxide.] Arch. antrop. et criminale, vol. 54, 1934, p. 413.

Vitro and in vivo studies to determine methods for finding evidence of sulfur dioxide poisoning at necropsy, the various methods for testing for sulfur dioxide in vitro, and the changes the sulfur dioxide may undergo are discussed. Sulfur dioxide, for example, may form sulfonic acid, or it may combine with hydrogen sulfide to form free sulfur or water. Hydrogen sulfide is apparently formed as a product of putrefaction after death. Since sulfur dioxide is a gas, it is readily eliminated from the body. It changes to sulfonic acid in contact with the oxygen of the blood and the moisture of the skin membrane.

The problem then was to determine actual sulfur dioxide poisoning and eliminate the possibility of getting positive results due to release of sulfur from protein breakdown or poisoning due to sulfurous acid or hydrogen sulfide. As there is also a danger in confusing hydrogen sulfide and sulfur dioxide, hydrogen sulfide was removed with lead acetate. Alkaline carbonate was added to transform organic compounds of sulfur dioxide into soluble alkaline sulfites. For positive results, immediate post mortem study is required in chronic poisoning. In acute poisoning the investigation is positive only if made within 48 hours after death.


The experiment was performed with rabbits and guinea pigs, using apparatus in which the concentrations of hydrogen fluoride inhaled were known. There was wide range of time (5 minutes to 41 hours) and concentrations (8-0.024 mg. of hydrogen fluoride per liter).

Evidence of irritation of respiratory tract at all concentrations was a constant feature as was a slowing of the respiratory rate. Increased exposure and concentration gave increased effect, including corneal erosion, necrosis of turbinates, and marked conjunctival and nasal discharges, indicating effect on exposed mucous membranes. When death occurred, it was usually due to bronchopneumonia.

The highest concentration tolerated by 2 men for more than 1 hour was 0.1 mg. per liter. At this concentration there was smarting of exposed skin, conjunctival and respiratory irritation, and a marked taste of the gas, which was described as flat and sour. Repeated low-concentration exposure (0.026 mg. per liter) failed to elicit any adjustment or habituation.

Pathologic findings of the experimental animals are discussed. (USPHS)


Smoke-abatement problems and progress are commented on briefly. Report is made on the work of the New York City Department of Health, which is said to have demonstrated a positive correlation of high smoke content of the air and incidence of cancer. On the physiological effects of smoky air it is observed that it is easier for the average man to keep up this bodily resistance to disease and to maintain vigor when he is making direct contact with strong sunshine and is breathing air of little dust content. (USPHS)


The morphology of the blood is not changed in sulfur dioxide poisoning, but there is an increase of acid and of sugar in the blood, and this acidosis may be the chief cause of death. Administration of soda lessens the severity of the symptoms in animals and prolongs life. (USPHS)


Air today is laden with irritating substances that affect people suffering from bronchial diseases. The worst sufferers are the men who do heavy labor as they breathe more deeply than sedentary workers. A table is given for London and Glasgow for 1915 to 1933, listing the deposits of total solids and sulfates (as sulfur trioxide). Tables express the total monthly deposit of 29 British cities.
1935


The dust storms that, because of drought and other factors, affected the west-central part of the United States in the early months of 1935, are reported briefly. The dust was so thick on some days as to completely obscure normal daylight.

Although no pathogenetic organisms were found in the dust, serious increase in respiratory disease incidence occurred. These are ascribed to the irritating quality of the siliceous nature of the dust. The particle size of the dust was rather large, significantly larger than silica particles capable of reaching the lung parenchyma. The evaluation of the increased incidence of respiratory disease was based on mortality as well as morbidity data. (USPHS)


Statistical evidence showed a close relationship between death rates and atmospheric conditions. Psychological ill effects were interrelated with the physiological; smoke gloom lessened the potential reserve, working capacity, and well-being of the individual and it increased fatigue, irritability, and restlessness; gloom induced mental depression.

Pastures in the neighborhood of an industrial town at one time could feed 2 cows per acre; now only 1 per 3 acres can be fed, and the cow’s milk is deficient in calcium. This deficiency causes rickets in children. (USPHS)


For this study a concentration of hydrogen fluoride was used that was above toxic levels but low enough to be relatively nonirritating and therefore a level at which chronic human exposure might occur. Higher concentrations are irritant enough to discourage prolonged exposure.

Animals used were guinea pigs, rabbits, and monkeys. In the exposed groups, significant pathological findings were limited to the lungs, liver, and kidneys. The guinea pigs showed organized pulmonary hemorrhages and mediate hematoxylination. There were some atelectasis and degenerative changes and hyperplasia of the bronchial epithelium.

The liver demonstrated scattered focal necrosis with fatty change in a portion in one guinea pig. The rabbits showed leukocytic infiltration in the lungs with or without edema. Two rabbits had acute lobar pneumonia with military abscesses. The liver showed slight fatty degeneration and necrosis of portions of the conulated tubules accompanied by varying degrees of compression or dilatation and with fibrous degeneration in areas of the cortex. Glomeruli showed inflammation, degeneration, thickening, increased cellularity, and sclerosis. Monkey pathology was confined to the kidney with degeneration and inflammation changes similar to above. (USPHS)


Six normal rabbits were fed food with a natural fluoride content. The teeth were found to hold a higher concentration of fluorine than the bones. However, the bones contained more than half the fluorine found in these rabbits.

Three rabbits, divided into two groups, were given different exposures to hydrogen fluoride. The concentration of fluorine in the teeth and bones as well as in the lungs and brain was increased. There were also severe pathological changes in the parenchymatous organs but no growth or nutritional retardation or physical changes in the bones were noted. (USPHS)


Mice were exposed in this experiment to exhaust gases in some cases and tobacco smoke in others for periods covering the greater part of their lives. It was hoped to find some significant factors at necropsy that differentiated the exposed animals from controls. Details of the experiments are given.

The exhaust gases and tobacco smoke did not produce any marked effect upon the general health. There seemed to be some increase in the incidence of primary lung tumors as the result of exposure to exhaust gas from the automobile consuming gasoline, which contains tetraethyl of lead, and also as the result of exposure to cigarette smoke. The increase is insignificant compared with effects of exposure to tarred room reported by Campbell. The difference between mice lung cancer and that in man is discussed. (USPHS)


Between December 1 and 5 of 1930, a heavy fog covered a large part of Belgium. A number of people were made ill; several hundred were severely attacked with respiratory symptoms, and 63 died on December 4th and 5th after only a few hours of illness. Many cattle had to be slaughtered. On December 6, the fog disappeared. Public opinion was deeply affected by the episode, and an investigation was begun immediately.

All the sick people felt retrosternal pain, had fits of coughing and dyspnea, and some had asthmatic attacks. In those who had asthma, cardiovascular collapse and symptoms of shock complicated the picture. In those who did not have asthma, hyperpnea, cyanosis, and a tendency to frothy sputum developed. The autopsy reports indicated that the noxious substance was inhaled during the last few hours of life. The first symptoms began on the third day of the fog. Respiratory symptoms disappeared on the sixth day when the fog abated. Symptoms were observed by the people throughout the valley at about the same time.

Chemical analyses: The chemists found 39 substances polluting the atmosphere, with maximum concentrations reached by carbon monoxide, carbon dioxide, nitrous gases, sulfur dioxide, and hydrogen fluoride. Through deduction, observation, and data obtained, sulfur dioxide appeared to be issued in the largest amount in the whole valley as a result of burning coal. Part of the sulfur dioxide was oxidized into sulfuric acid. Only by the action of sulfur pollution could the simultaneous illnesses occurring along the entire valley be explained. The pathological findings also favored sulfur dioxide and sulfur trioxide as the offending gases. (USPHS)


The various agencies of smoke the most important is soot. This is associated with tarry products of combustion that make it very adhesive, so that it sticks tightly to that with which it comes in contact. Soot obscures the air, prevents penetration of sunlight, decreases visibility of objects, and diminishes power of sunlight to destroy bacteria.

The other element in smoke is sulfur dioxide,
Soot has a definite adverse effect on lungs. It produces permanent injury to lungs, diminishes the vigor, and decreases resistance to pulmonary diseases due to inhalation of smoke are discussed.


One hundred mice were subjected to an atmosphere of soot and 50 mice were used as controls under normal laboratory conditions. Autopsies were performed on the mice as they died. Twenty-one percent of the experimental animals developed hyperplasia of the bronchial epithelium. In this experiment, cancer of the lung in the experimental group was four times as great as in the control group.

There is a two-page table of deaths due to cancer of the lungs in the rural and urban areas of each State of the United States from 1930-54. It is interesting to note the consistent and markedly higher death rates in cities. From known data, the author concludes or suggests that there is some relation between primary pulmonary cancer in the cities and smoke and soot. (USPHS)

1937


From the chemical point of view, the whole problem ranges around the practical effects of the adsorptive capacity of the carbon particle. The possible, wide public significance of this absorbent power of carbon is only now being realized. For, as suggested, (1) the coal particles may prevent silicosis in miners by absorbing bacteria that would otherwise be introduced by silica particles, (2) the carbon particle may prevent gas poisoning by its adsorptive power for the gas molecules, (3) the soot particle may cause respiratory poisoning by carrying into the lungs through respiration bacteria, acids, etc., previously adsorbed from the atmosphere, and (4) the soot particles may selectively absorb oxygen from the atmosphere and devalue as well as pollute it.

From the medical viewpoint the problem ranges around the great extent of bronchial diseases due to atmospheric pollution of all kinds; the loss of ultraviolet rays; the loss of sunlight bactericidal action; and the psychologic effects of depression and gloom.

Refers to the increasing number of patents taken out in connection with atmospheric pollution, one of which is said to provide a means of (a) totally removing all smoke pollution, (b) utilizing valuable by-products of coal consumption, and (c) increasing consumption of coal.


The Tharandt Zoological Institute has known that animals in certain parts of Saxony have peculiar injuries to their hair. There is sometimes a loss of hair in spots or over the entire body, the skin having a black appearance. From a study of a few skin samples, it was determined that parasites, sarcoptids, or fungi could not be found as the pathogenic agents. The red deer were affected the most.

The stratum corneum was found to be thickened. Investigation convinced Pfehl that the arsenic acid in factory fumes was responsible. The arsenic was deposited on the ground and on vegetation as finely divided dust some miles from the factories.

Scleroderma together with alopecia and a strange rough appearance of the skin were found in the red deer; the individual hair had lost its cylindrical appearance and dried up. The mucous membranes of the respiratory tract were inflamed as was the mucosa of the digestive tract. The connective tissue showed a gelatinous infiltration with noticeable thickening. There was cirrhosis and swelling of the liver in some cases. Malformation of the antepulse of the heart were observed.

Three possibilities of the effect of arsenic are: (1) A direct poisonous effect of the arsenic through irritation and cauterization of the surface of the tissues that the poison reached from the outside; (2) an indirect poisonous effect on the organs through absorption of arsenic; and (3) a disposition-changing effect of arsenic. The power of the body to resist other injuries is reduced, and these other injuries lead to more serious results.

Epidemic paresis noted in some red deer was also due to arsenic poisoning. The results of the investigation revealed that arsenic poisoning is amazingly widespread. Rain can wash the arsenic from the vegetation and thus pollute the streams. (USPHS)


The study is limited to epidemic colds that pass through families and neighborhoods, as does measles, in contrast to flue-ups of sinusitis or streptococcus sore throat. The use of sulfur dioxide was prompted by success in destroying plant viruses with 0.6 to 1.5 percent sulfur dioxide.

Sulfur dioxide was administered by Inhalation of sulfuric acid gas. Of 80 patients, 14 received no relief, and 66 stated they were completely cured on the first or second day after therapy was begun. These 66 patients stated that their colds usually lasted 1 to 2 weeks. Treatment in each case was given in the prodromal stage of the cold. The same therapy was tried after 3 or 4 days of onset with virtually negative results. It was found that in what was apparently an epidemic of cold, sulfur dioxide gas inhaled in the first 12 hours stopped the cold in 24 hours in a large percentage of the cases. The technique required getting the sulfur dioxide gas into the upper respiratory tract without getting appreciable amounts into the lungs. The possibility of decreased colds among workers exposed to sulfur dioxide is discussed. A few workers were questioned, and one plant manager in a plant where there was exposure to sulfur dioxide found that the colds were infrequent. (USPHS)


Describes histological changes in the lungs and in the blood consequent upon exposure to the inhalation of smoke from anthracite, coke, and bituminous coal. Rabbits, rats, and mice were used. The exposures extended over 80 days for 23 hours a day. Compared with control animals, of which the weight gain was taken as 100, the rats exposed to anthracite smoke gained 105, those exposed to coke smoke 114, and those exposed to bituminous smoke 75; the rabbits exposed to anthracite smoke gained 84, those exposed to coke smoke 77, and those to bituminous smoke only 9. The most pronounced blood changes occurred, in the direction of leucocytosis, with hemoglobin and erythrocyte increase, among the animals subjected to bituminous-coal smoke; with fewer in the coke group and least in those exposed to anthracite smoke. Plagocytosis of carbon pigment and subsequent deposition in the tissues of the lungs was pronounced in animals exposed to bituminous smoke, less pronounced in those exposed to coke smoke, and only slight in those exposed to anthracite smoke. No suggestion of fibrosis was seen in the lungs of the animals exposed to anthracite or coke smoke, but in the lungs of those exposed to bituminous smoke, spindling of the carbon-laden cells—apparently the anes of the stage of fibrosis—was noted. Before placing all the adverse findings down to the bituminous nature of the smoke, it should be noted.
that dust counts showed the average number of particles present per cubic centimeter to have been: Bituminous coke, 4,410; coke, 8,070; and anthracite, 312. Nevertheless, the amount of fuel burned per hour was the same in each case, 1,000 grams. (These results are of interest in relation to atmospheric pollution in industrial districts and large towns.) (IH)


Pulmonary fibrosis due to, or associated with, siliceous dust in occupational groups predisposes to tuberculosis, whereas fibrosis due to pigmentation in nonoccupational groups does not. The opposite appears to be true of pneumonitis.

The method used in the experiment is described. On autopsied rabbits and rats, bronchopneumonia and purulent bronchitis were encountered. The peribronchial lymph nodes were enlarged and thickened. Polyhedral leukocytes were present. No fibrosis was present. Areas of darkest pigmentation, the alveoli had collapsed. The walls of the collapsed alveoli were congested, thickened, and filled with mononuclear cells and leukocytes. Animals killed 103 days after the termination of the experiment showed fibrosis.

Carbon is thought to have been responsible for both the pneumonitis and the fibrosis. (USPHS)

1938


Ascher suggests that the increase of smoke in industrial towns must have some bearing upon the increase in diseases of the upper respiratory tract, because, according to his investigations, acute pulmonary diseases are more frequent in industrial towns than they are in the country. (USPHS)


It is felt that smoke is definitely harmful to health and that smoke-abatement programs should seek to become more effective. Domestic smoke is considered to be more injurious than that from industry. Methods are suggested to reduce the smoke menace. (USPHS)


An analysis is made of 3,000 autopsies following deaths from various diseases in Pittsburgh. Examinations were made to determine the kind and extent of lung change and the amount of visible dust deposits. The autopsies represent a cross section of the population. Correlation of pneumonia deaths with smoke showed increased incidence of pneumonia during the following smog. Pneumonia morbidity decreased in economic depressions when industry was at low ebb.

Necropsied lungs were graded macroscopically for pigmentation and fibrosis. All forms of pneumonia were graded as to pneumonic type. Gradings ranged from 1, representing minimal pigmentation, to V for excessive fibrosis and pigmentation. Grade O meant no pigmentation. Correlation was then attempted between the type of pneumonia and pigment grade. Groups I, II, and III had no occupational basis. Grade III was mixed occupational and nonoccupational. Groups IV and V were almost all related to occupation.

No relationship was found between incidence of pneumonitis and mild grades of pigment. In Grades IV, and V, there was a definite higher percentage of pneumonitis, but the average age for these grades coincided with the age when the pneumonia death rate in less smoky cities is likewise highest. Healing by organization was increased in upper grades. Conclusion: No significance should be attached to pneumonia and pigmen grades except increased organizing fibrosis with marked pigmentation of lungs. (USPHS)


Although air pollution is hygienically undesirable, definite proof is still lacking that smoke is significant from the standpoint of health. (USPHS)


Harmful physiological effects of smoke include all kinds of respiratory diseases such as common colds, hay fever, asthma, influenza, diphtheria, whooping cough, pneumonia, and tuberculosis; skin diseases of various kinds; stomach disorders in certain instances; and rachitic diseases, which are the result of obscuring ultraviolet radiation by atmospheric pollution. Economic losses due to coal smoke are discussed. Methods are given for reducing and preventing smoke. Most of the article is confined to the properties, sizes, and uses of bituminous coal and its products of combustion. (USPHS)


Reports series of cases of adults of similar social status, studied for the relation of dust deposits in the lungs. The pneumonocinosis cases and death rates and the incidence of pneumonia cases in which organization occurred were found to increase in direct proportion to the degree of pneumonocinosis. A similar increase was found in the incidence of bronchitis and emphysema. The occurrence of active tuberculosis and the tuberculosis death rate were found to be inversely proportional to the degree of pneumonocinosis.

The type of dust prevalent in the Pittsburgh district is made up largely of carbon particles and amorphous ash from soft coal. Very little free silica is present, yet the amount of fibrosis found about pigment-bearing cells was considerable. Although there was a relatively large number of cases of primary cancer of the lung, the occurrence was interpreted as having a relation to the age group, as there was a concurrent increase in extrapulmonary malignancies. (USPHS)


The general thesis is that smoke has not been proved guilty of causing tuberculosis by means of its effect upon the respiratory tract. Various works are cited to substantiate this view. In fact, it is conceded by some, including the author, that inhalation of coal smoke has a protective effect against tuberculosis. (USPHS)

1939


Tarry matter from roads as well as chimney soot both have been proved to produce skin cancer. Carbon in the soot mitigates this action somewhat, and inorganic substances in tarry matter aid the production of skin cancer. Soot from exhaust has little carcinogenic effect.

The dust from tarred roads seems to be the most dangerous source of carcinogenic agents; when inhaled it gives the highest cancer incidence in mice. (USPHS)

Discusses the fire-explosion and health hazards resulting from gases, liquids, and dust produced in coke works. (USPHS)


The question is asked why it is that communities, otherwise sanitary, continue to tolerate air pollution. No civilized community expects its citizens to drink bad-smelling water, and unsanitary, but few communities worry much about bad-smelling, dirty, and unsafe air.

Theills for which polluted air is at least partly responsible are listed as irritation of the mucous membrane of the respiratory passages, causing congestion that interferes with the protective secretion of the mucous membrane, making the congested part susceptible to infection; sinus infection due to irritation by smoke-laden air; allergy due to sensitization by certain types of air pollution, sometimes resulting in asthma; eye irritation resulting in conjunctivitis and eye-stain from improper daylight illumination; and lowering of resistance to disease by lack of vitamin D through the absorption of ultraviolet rays on the surface of the body as well as increase in circulation of dangerous bacteria and viruses through absence or low intensity of the ultraviolet rays of the sun.

Seven general nontechnical suggestions are made for eliminating air pollution.


A 15-month survey was conducted to determine average amounts of sulfur gases in the air of more than 25 American cities. Five metropolitan districts received more extensive study. Measurements were taken at all hours of the day and night and during all seasons of the year. Results varied from a high of 0.128 p. p. m. in St. Louis to 0.009 p. p. m. in Washington, D. C. It was concluded the amounts (even the maximum reading, 2.293 p. p. m., found in St. Louis) were insufficient to cause harmful physiological effects. Home fires using high-sulfur-content coal, which produced sulfur gases, were found to be big contributors to the pollution. Concentrations were higher in the cold seasons than in the “heating seasons.” A close relationship existed between wind velocity and pollution, the highest concentration being found on foggy nights. (USPHS)


The magnitude of the job of smoke abatement is emphasized, and practical suggestions are made for its accomplishment. The limitations of methods and equipment are discussed. A report on 100,000 questionnaires titled “Smog and You” used in the Pittsburgh area revealed that during smog 53 percent had nasal obstruction; 62 percent, a sense of rawness or tickling in the throat; 25 percent, increased coughing; 22 percent, increased “sneezing troubles,” and 9 percent, no complaints. (USPHS)


Guinea pigs were subjected for varying periods of time to the inhalation of ethylene oxide and chloride and carbon monoxide and to the action of cold (3°-4° C.). Circumscribed areas of emphysema and atelectasis were more pronounced after long inhalation of ethylene oxide than with the other gases studied. Necrosis of the bronchial epithelium occurred only after chloride inhalation. Vasodilatation was present also. Interalveolar edema was also slight after inhalation of ethylene oxide and carbon monoxide, very severe after chloride inhalation, and pronounced after exposure to cold. Peribronchial edema occurred only after chloride inhalation. Alveolar edema appeared early after inhalation of chloride and carbon monoxide and late after ethylene oxide inhalation of chloride and carbon monoxide but was not otherwise observed. The appearance of edema in the alveolar epithelium and capillary epithelium was found only after the inhalation of ethylene oxide. The desquamation of the alveolar epithelium, which has been considered characteristic for war gases and anthrax, in animals also after the action of carbon monoxide is it is therefore not characteristic, at least in the guinea pig. (USPHS)


Samples of atmospheric air in Buenos Aires submitted to spectrographic studies revealed substances with the same spectrum and the same fluorescence characteristic for certain unsaturated, polycyclic hydrocarbons. These latter are considered analogous to the products of incomplete combustion of petroleum products, which are shown by the author to be carcinogenic. The danger of the production of lung cancer by an atmosphere in which wastes of motors are emptied is stressed. Allusion is also made to the carcinogenicity of tobacco tar. (USPHS)


Cook believed, on clinical grounds, that there may be a certain specificity in the inhalation of sulfur dioxide fumes, principally because this gas initiates attacks in relatively few asthmatic individuals, and in those who were free from asthma attacks for some time. However, there is no immunological proof of the specificity of sulfur dioxide fumes in initiating attacks of bronchial asthma. Those exposed to sulfur dioxide fumes have an inflammatory, destructive lesion in the upper respiratory tract. The mucous membranes are rendered helpless, and the bacteria gain the upper hand. Inhalation of sulfur dioxide is very irritating to the upper respiratory tract. Sulfur dioxide plus moisture of membranes forms sulfuric acid, which is very irritating and in severe cases can produce bronchopneumonia and pulmonary edema. A group of 100 people with chronic exposure to sulfur dioxide had a diminution of taste and smell, an increase in pharyngitis and tonsillitis, and an increase in fatigability and dyspnea on exertion. Three cases of asthma in refrigerator-repair men are cited in which sulfur dioxide is said to be the cause of the asthma. (USPHS)


The “ear, nose, and throat club” of St. Louis, Mo., claims that smoke irritates the membranes of the respiratory passages, creating a fertile field for secondary infections. The Trudeau Society states: (1) Smoke is a definite irritant to the upper respiratory tract; (2) smoke produces an irritating cough; (3) it aggravates the cough of existing broncho-pulmonary diseases. (USPHS)


Effects on animals of exposure to sulfur dioxide include general visceral congestion, edema of the lungs, and slight hemorrhage. Acute dilatation of the right heart, gross distention of the stomach with multi-
tiple ulcers and hemorrhages, and distention of the gall bladder. (USPHS)

1940


The injurious effects of the solid and gaseous constituents of smoke, especially sulfur dioxide, on the human organism and on buildings are discussed. (USPHS)


Discusses clinical case of a fatality following inhalation of sulfur dioxide. The patient was carrying a small tank of sulfur dioxide which burst, and he was admitted to the hospital the following day. Immediate symptoms were nausea, vomiting, hypothermia, retrosternal and epigastric burning, and irritation of upper air passages. Examination on the following morning revealed a temperature of 38° C.; pulse 130, slight cyanosis, hoarseness, seropurulent cornea, bilateral rhonchi, subcutaneous rales, and some sibilant rales. Later these were signs of pulmonary edema and diffuse bronchitis. Temperature 39° C.; and intense cyanosis, pulse 120. B. P. 110/60. The nervous system was normal. After 3 days there was a decrease in temperature and an improvement in the general condition, which was maintained for 1 week. Then the temperature rose again with exacerbation of the dyspnea and with many coarse and moderate subcutaneous rales. The pulse was 120. Icterus then appeared with tenderness over liver. The electrocardiograph next revealed auricular flutter with ventricular rhythm of 140. Approximately 2 months later he died suddenly. No autopsy was performed. (USPHS)


Dogs were allowed to breathe air containing 0.01 percent of hydrogen sulfide for 7 hours daily for 2 months. The only symptom observed was some irritation of the nasal mucous. (USPHS)


Thirty-eight chimney sweepers were examined, of whom 19 were over 35 years of age and 12 over 50. The chimney sweeper does his essential work up to about the age of 25, after which he is as a rule a master, concerned only with expert opinions and consultation. The younger men are slender and asthenic, the older ones likely to be of the pyknic type, fat, and often heavy drinkers.

The inhalation of soot produces bronchitis and work in the narrow chimney causes bursitis praepatelaris, arthritis of the knees, and myalgic pains in the legs. Changing from hot chimneys to the cold air produces rhinitis, narrowing of the nose (up to 122) and polythemia (up to 7.6 million), especially among the older men (7 of 18). It is thought that chronic CO poisoning is the most important cause of these blood changes (but the older men have not been exposed to CO for many years). The material is certainly too small for such extensive examinations, and the author forgets that the damaging factors in the older men of this profession may arise from other sources than chimney sweeping—perhaps overeating and overdrinking. (JHIT)


Descriptions and illustrations of cauterizations on knees, elbows, and hands of a chimney sweeper. He cleaned the chimney of a factory where a great deal of coal was employed, the fumes of which went up the chimney. In rainy weather, the man's clothes became wet, which promoted the irritation. (JHIT)


In cases where only 0.1 to 0.2 p. m. sulfur dioxide were used on experimental animals, nothing injurious happened because the sulfur deficiencies of nutrient supplies were augmented by the atmospheric sulfur dioxide. Factors influencing the effect of sulfur dioxide on plants are: (1) Resistance was greater at 40° F. or below; (2) resistance decreased with increases in relative humidity; (3) ample water supply made them more susceptible; and (4) younger plants were more resistant than older ones. Reviews the studies of effects on animals of prolonged exposures to sulfur dioxide. (USPHS)


Some examples are mentioned of mechanical irritation of the mucous membrane of the nose. It seems that there is a resemblance of the symptoms of this sort of irritation and those of hay fever and vasmotor rhinitis. With mechanical rhinitis one does not find positive skin reactions, though, on the contrary, with allergic rhinitis it may often be found. The symptomatology of mechanical irritation of nose (and eyes) is described from the literature and from the author's own observation, and therapeutic measures are mentioned. (USPHS)


Houses, mice, and rats were exposed to a continuous flow of ammonia, chlorine, hydrocyanic acid, hydrogen sulfide, and sulfur dioxide gases under controlled conditions at concentrations of 12, 50, 250, and 1,000 parts per million for periods up to 10 hours. Toxicity curves are presented at various concentrations of the gases. The order of decreasing toxicity for these gases was found to be hydrocyanic acid, hydrogen sulfide, chlorine, sulfur dioxide, and ammonia. With sulfur dioxide the signs qualitatively resembled those of chlorine. The rats showed edema and hemorrhage in the lungs. Dilatation of the heart and moderate dilatation of the stomach without ulcers also occurred in the rats exposed to sulfur dioxide. (USPHS)

1941


The parallelism between gastric cancer incidence and the use of smoked food was studied. The study concluded "that wood smoke, as used for the preservation of human food, contains no carcinogenic compounds which can be detected by its effect on the skin of the experimental animals used." (USPHS)


Permanence tendency hypoplasia of the enamel, defective and irregular calcification of dentine, and hence early and irregular wear. The teeth show changes as in rickets, in adult animals as in osteo-
malacia. Fluorine interferes with the action of the phosphatases, which are necessary for calcification. There seems also to be an inactivation of ascorbic acid and a reduction of glycogen. (USPHS)


As a result of a year all the carefully built-up practices and regulations in smoke abatement have been thrown overboard. The effect of this upon the public health was already evident as long ago as 1940 and must be becoming more evident now than ever before.

The Medical Officer of Health of Salford, a highly industrialized town, reported for 1940 that there had already been a marked increase in the deaths in Salford due to respiratory diseases. It is thought probable that the increase in atmospheric pollution brought about by the raising of restrictions upon the production of smoke has been largely responsible for the increase in the number of deaths from bronchitis by 158.

With the advent of war in September 1939 health activities had necessarily to take second place to national survival. The crowning instance of this retrogression was the Government instruction to the effect that emission of smoke from chimneys should be encouraged. Such proceedings may be justified on the grounds of lessened visibility to enemy aircraft, but from the health point of view it is an absolute mockery.

The end of the war will be the opportunity for a great forward movement for better health conditions. One of Salford's greatest needs is a clean atmosphere, which can be achieved by a national effort involving national control of the country's fuel resources.

Under present chaotic conditions, the respiratory organs of human beings are irreparably damaged by huge emissions of flammable coal products that should be conserved and used for power and transport. Gross national waste goes hand-in-hand with avoidable mortality and child mortality.

Gas and coke are the fuels that can bring about smoke abatement at the lowest cost and with the maximum value to the Nation. In the interests of national health no less than in the interests of coal conservation the Government should see that the carbonization industry receives every encouragement after the war as a feature of postwar reconstruction.


The irritant gases used in the study of the effects on ciliary activity were ammonia, hydrogen sulfide, formaldehyde, sulfur dioxide, chlorine, nitrogen dioxide, and hydrogen chloride gas. The concentration of these gases producing immediate irritation of the throat agreed roughly with the concentration that causes cessation of ciliary activity without recovery after an exposure of 10 minutes. Thus the concentration that produced immediate irritation of the throat offers a comparative index for the deleterious effect of these gases upon ciliary activity when the exposure is for a short period of time.

For the study, tissue was excised before the cilia were subjected to the gases. Susceptibility of the cilia to gases increased with the lapse of time and removal from the experimental animal. Exposure to small amounts of irritant gases for long periods of time may lead to a chronic irritation of the mucosa, which would accordingly affect ciliary activity. (USPHS)


The experiment conducted with wood-smoke condensates on mice is of interest in that essentially no local tumors developed on the skin where the materials were rubbed. In another experiment, rats were fed smoked foods, and no neoplasms developed. Many reasons were suggested for this “apparent failure” to produce cancer with smoke products. (USPHS)


The greater number of deaths from fires is the direct result of the action of smoke and fire gases. In this study the various constituents released during the combustion of certain materials are enumerated. It is concluded that probably most deaths are the result of carbon monoxide poisoning. Certain substances, when burning, may release enough toxic material, such as
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hydrogen cyanide, ammonia, hydrogen sulfide, and sulfur dioxide, to contribute directly to the fatal event. The effect of these gases in combination is suggested to be greater than an individual effect, so that gases that are sublethal alone may form lethal concentrations when combined with other gases at sublethal levels. The author cites Hofer, who found that carbon monoxide and hydrogen sulfide in concentrations that were not lethal when breathed alone became lethal to animals in 10 minutes when mixed. Similar results were achieved with carbon monoxide and hydrogen cyanide. Reference is also made to Luce’s work on mice, which points out that most combinations of vapors at low concentrations showed additive effects. (USPHS)


Particulate matter is dispersed in two ways, dynamic projection and air carriage. No general law can be said to govern the velocity and direction of the spread of particulate matter, and it can be said only that enough air movement exists to insure positive dispersion of the particulate matter. The respiratory tract, as mentioned in other sections, serves to free inspired air from harmful concentrations of inspired dust. Its efficiency is close to 100 percent for particles of 5 microns and larger and goes down to 20 percent for particles of less than 0.5 microns. An agglomeration of particles acts as a unit, and hence the efficiency of dust removed in the respiratory tract increases with the degree of flocculation of the inspired material. (USPHS)


Soot, as a cause of cancer, is discussed from the standpoints of the medical and technological aspects, historical data, and geographical distribution and incidence of soot cancer. There are notes on exposure, age incidence, symptomatology, pathology, predisposing factors, experimental soot cancer, and precautionary measures. A final section is devoted to the medicolegal aspects of the problem. (USPHS)


Many investigations of smoke damage during the last two decades have placed considerable emphasis on the chemical analysis of the air. Proper weight has not been given to a study of the effects and examination of objects damaged. Arsenic and fluorides have been slighted as toxic agents with excessive emphasis given to sulfur dioxide. (USPHS)


Among the products of combustion from gasoline motors some belong to the group of compounds considered to be carcinogenic. Rats respiring products of combustion of petroleum at high concentrations developed carcinoma of the lungs with widely distributed metastases. Ingestion of the black deposit formed by the combustion produced a papillomatous hyperplasia of the gastric epithelium, ulcers of the mucosa, and hyperplastic development of the glands. The liquid product formed by combustion of petroleum when applied to the skin of rabbits produced malignant tumors. The danger of soot is pointed out. (USPHS)


This is a study of traffic officers stationed at the Holland Tunnel, between New York and New Jersey, for 13 years. The average daily carbon monoxide concentration was 70 parts per million.

Most of the officers were symptom free, and when complaints were made, they tended to be nonspecific. Some had throbbing frontal headaches, some dizziness, anorexia, mild nausea, and spots in front of their eyes.

From the data obtained, apparently the hearts of these men had not been damaged by carbon monoxide in the tunnel. Several individual cases showed some changes, but these were not attributed to the carbon monoxide. Twelve percent of the group of 156 men had a fine tremor of the outstretched hand. No other neurologic changes were noted. A number had simple sceral injection due to coughing. The remainder of the examination showed no unusual abnormalities.

It was found that the amount of hemoglobin combined with carbon monoxide was directly related to smoking habits. The average red blood cell count was 5.2 million cells.


The occurrence and nature of gastric ulcers in guinea pigs and mice exposed to sulfur dioxide levels of 10, 25, 50, 100, 150, 200, and 1,000 p. m. are described. No effects on the stomach were observed below 65 p. m. At 65 p. m. one-third of the animals showed acute distention of the stomach on the ninth day, and at 100 p. m. half of the animals showed distention on the fourth day and two gastric perforations occurred.

It was concluded that the study did not reveal any evidence of injury to health attributable to carbon monoxide exposure at the levels encountered. (USPHS)


Skin lesions were the result of exposure to smoke from burning Binjai firewood. (USPHS)


A study was made of the relationship between air pollution and respiratory disease, with a comparison between Cincinnati and Pittsburgh. The sootfall and pneumonia rates were found to be much higher in Pittsburgh. In both cities, sootfall and pneumonia rates were higher in the low-lying industrial areas. A similar close relation was found to exist in the economic indexes compared favorably with the results to add another possible causative factor. The increased incidence of pneumonia in men was attributed to greater exposure in view of the insignificance of the sex difference in rural areas. The winter smog is discussed as an important agent in the incidence of pneumonia. The possibility of carcinogenic material in smoke is also mentioned.

Recommendations are made for reducing air pollution: The use of low-volatile coal, fly-ash trapping, preliminary coal washing, and use of diesel locomotives. (USPHS)


After a brief survey of respiration, lungs, blood, tissue, and the necessity for oxygen, toxic gases are classified, their effects described, and the prophylaxis is indicated. The first group, acting to prevent absorption of oxygen in the lung, is composed of toxic anoxemians such as NH₃, HCl, H₂SO₄, HF, HCHO, and particle action upon the upper respiratory tract, and such as SO₂, Cl₂, Br₂, acrylaldehyde, H₃S, nitrous vapors, and phosgene acting both upon the upper respiratory tract and the lungs. The second group, acting with the oxyhemoglobin in the blood, is composed of toxic anoxemians, including CO. The third group is composed of.
tissue poisons that prevent utilization of the oxygen in the blood and includes the cyanides compounds of Hg, P, and particularly the H derivatives of the latter. (CLAC/UCLA)

1945


Sheep in the immediate neighborhood of an aluminum factory developed fluorosis as follows: 100 percent of the flock 1/2 mile away, 62 percent of those 3/4 mile away, and 46 percent of those 1 1/2 miles away. The teeth were mottled, wore poorly, and were subject to infection. The fluorne content of the teeth varied from 0.25 to 0.80 percent (normal 0.15-0.19 percent). The herbage in the nearest area contained 61 parts per million of fluorne; the next field 44 parts per million; and the soil, 51 parts per million. Running water from a stream nearby contained 0.1 part per million of fluorne. (USPHS)


Types of fires are classified as to material burned. The chief hazards are anoxia, caused by carbon monoxide, nitrogen oxides, and the carbon particles, with resultant death and injury from blast, heat, or direct flame. The use of a gas canister is discussed as well as treatment of smoke casualties. The treatment centers are maintained in adequate respiration, with all means at hand. (USPHS)


In addition to the direct or indirect monetary cost there is a vast cost in ill health and mortality owing to respiratory diseases. It is believed that 20,000 children are killed each year through smoke, although a report from a competent medical body on this subject is desirable. Some information is available on the loss of daylight through smoke, but the information is not final. A survey of ultraviolet daylight in and near Leicester showed that near the center of the town in winter about 20 percent of the possible ultraviolet light was lost through pollution. In other towns measurements have shown energy losses throughout the year of 25 to 50 percent, with a loss of ordinary daylight about the same as ultraviolet daylight. To get the maximum effect from smoke abatement the aim must be to abolish smoke completely.


There exists a highly significant relationship between atmosphere pollution (soot) and respiratory disease death rates in the various districts of Cincinnati and Pittsburgh. (USPHS)


Primary lung carcinoma is definitely on the increase. The incidence is higher in the male. Some etiological factors in lung cancer that have been considered are: Inhalation of particles of chromium, lead, silica, radioactive ores, light-oil derivative of coal tars, smoke of tobacco, and industrial smoke. (USPHS)


The clinical picture and pathogenesis of carbon monoxide poisoning and the existence of the poisoning in drivers of motor cars operated by charcoal gas in Finland are described. Of the 5,000 drivers who were questioned, symptoms of carbon monoxide poisoning were found in 67.5 percent of the cases. The symptoms of acute poisoning were complained of by 3,898; symptoms of chronic poisoning by 2,506 drivers. In 550 cases the poisoning had caused inability to work. In Finland, at present, carbon monoxide poisoning is the most common occupational disease. (USPHS)


An apparatus has been constructed for measuring the concentration and size of particles in aerosols in the conditions under which they normally exist, that is, in suspension. The method of illumination used, as described, increases the apparatus resolving capacity, which gives it a great advantage over all former models. The working range of the apparatus is very wide, extending from particles subject to the Brownian movement up to particles several microns in diameter. Determinations and calculations when using this newly constructed apparatus take minutes to do instead of hours, as required when working with the Owens apparatus, and can be made by any observer without preliminary experience. The apparatus is portable and can be widely used in expedition work. (FA)


A droplet of sulfuric acid, the form in which sulfur trioxide would exist in a mist, will be stable at a lower relative humidity than a droplet of water. Therefore, once a fog is formed in an atmosphere containing sulfur dioxide, it will tend to be a more persistent fog than one in an unpolluted atmosphere. It will be a more objectionable one because of its corrosive and irritant character.

The report of the Committee on Public Health Relations of the New York Academy of Medicine is cited: Inhalation of carbon particles and irritating fumes lower the resistance of the nasal mucous membrane, rendering it susceptible to acute and chronic infections that may involve the ear. Enlargement of the tonsils and redness and congestion of the pharynx and larynx have also been ascribed to atmospheric pollution. Smoke likewise irritates the membranes of the entire respiratory tract, predisposing to pneumonia and emphysema. Smoke diminishes the potential reserve, working capacity, and well being of the individual and increases fatigue and irritability, whereas sunshine exerts an exuberant influence. (USPHS)

1946


With improvement of the smoky atmosphere in St. Louis, Mo., otorlaryngologists agreed that there has been a definite reduction in infections of the upper respiratory passages and of the tracheobronchial tree. The smoke used to cause serious and permanent damage to the membranes of the nose, sinuses, and lungs, rendering these membranes susceptible to secondary infections, influenza, laryngitis, bronchitis, pneumonia, etc. Smoky air aggravated asthma. (USPHS)


Cases are reported of industrial fluorosis in cattle on farms in Lincolnshire neighboring the site where ironstone is being calcined with the probable release in the smoke drifting over the area, of silicon fluoride. The crippled cattle were found to have a urinary fluorine level of 26-29 p. p. m. The water on the affected farms was found to contain only 0.5 p. p. m. fluorine, but the grass fluorine content was over 2,000 p. p. m. in some areas. The human family on the same
farm showed urinary fluoride levels of 1.3 to 4.2 p. p. m. In 9 cases. The danger zone is not expected to exceed 2 miles. (APB)


Irritant gases act as corrosives on the mucosa of the eyes and respiratory tract. Their effect remains limited to the surface of the tissues with which they come in contact. The greater the water solubility of a gas, the higher is the irritant effect on the respiratory tract. Gases hardly soluble (for example, nitrous oxide) act first at the deep parts of the bronchioles and alveoli where the effects have more serious consequences. The nose and throat are less sensitive to the gas than is the deeper respiratory tract, and there is less chance of damage here. Corrosion of the larynx, trachea, and bronchi can lead to marked edema of the glottis and the respiratory passages and complications in the lung. Damage to the bronchioles and alveoli leads primarily to severe disturbances of respiration or even to fatal lung edema and possibly heart failure.

There are protective devices against gases, but carbon monoxide can overcome these and subject the person to the deep penetration of smoke and its components. Only 0.2 percent concentrations of carbon monoxide are necessary to produce carbon monoxide death. Carbon monoxide poisoning and pathology are discussed.

Smoke is similar to carbon monoxide poisoning plus the additional effects of irritating gases. There are innumerable irritations of the conjunctiva and air passages with coughing. The irritation of inspiration of smoke may cause catarrah, and pulmonary complications. At autopsy, the inflammatory reddening of the mucosa of the respiratory tract stands out. Lung irritants do not cause lasting damage, while the irritant of the upper respiratory tract causes to chronic bronchitis, pulmonary fibrosis, and bronchiectasis. Fourteen cases of smoke poisoning due to large fires are reported. All cases showed irritation of the respiratory tract. Blood findings showed increase of hemoglobin and an increase in red blood corpuscles and white blood corpuscles with a shift to the left. In all cases symptoms of carbon monoxide poisoning could be seen. They dominate the first stage of smoke poisoning, which is characterized by the loss of consciousness. They were symptoms of irritation of the mucosa. The early lung edema may always be regarded as the result of smoke gas, especially nitrous oxide. (USPHS)


The deleterious effect of air pollution on health is emphasized as much more important than the economic damage and the drab and dirty appearance of the industrial city. The various components of smoke are dealt with separately. Carbon particles in the air have never been shown to be harmful to man in any way. Hydrocarbons form the tarry material on the soot flakes, and it is this tarry carbon that dirties clothing. Certain of the condensed tar constituents have been shown to be some producing various types of cancer in susceptible animals and have been suspected of being factors in the rapidly rising lung cancer rate in man. Sulfur gases are an irritating factor of smoke. These gases when inhaled by man are quickly and completely dissolved in the moist linings of the air passages and exert their irritating effects ** **. Carbon monoxide is of little consequence in the city atmosphere generally. (USPHS)


Certain industrial cities, as a result of their local topographical features, present sharp local differences in the degree of pollution. Cincinnati and Pittsburgh are two such cities. The sootfall in both cities is highest in the low-lying areas of the river bottom. Figures indicate the close relationship of high pneumonia death rates to heaviest sootfall. Atmospheric pollution with coal-combustion products sharply increases the respiratory disease hazards of the inhabitants of an industrial city. Present day pneumonia and tuberculosis statistics in Pittsburgh and Cincinnati, showing death rates that rise sharply with increasing degrees of atmospheric pollution, provide emphatic support for the Rhine Basin findings of Ascher many years ago. Study of a large series of surgical records revealed postoperative pneumonia to be six times more prevalent among patients who had been tobacco smokers up to the time of hospitalization than among nonsmokers. The conclusion is that there exists a direct and highly significant relationship between air pollution and infectious diseases of the respiratory tract in man. (APB)


Fifty years ago in London, chimney sweeps had a high incidence of skin cancer on the exposed areas. Slighty under 100 Cincinnati people die each year from cancer of the respiratory system, and this deadly affliction strikes most frequently among the unfortunate people who makeup the upper working classes of the city where atmospheric pollution is greatest. Males are involved five times as frequently as females.

A chart is used for comparison of the respiratory tract cancer deaths per 10,000 males for a 5-year period with the average carbon deposit per month in different parts of the city. In general, the cleaner suburbs of the city have low respiratory cancer rates, while the more industrialized low-lying districts have higher rates. This is the same relationship as was found for pneumonia and pulmonary tuberculosis. There seems to be little doubt about the high price paid in respiratory disease and death as a result of atmospheric pollution in certain parts of Cincinnati. Remedial steps are given. (USPHS)


Ascher pointed out that the pneumonia mortality is 133 percent higher in men of the Ruhr Valley than in Prussian men of similar age groups, with the death rate highest in the industrialized areas of greatest pollution. Pneumonia causes six times more deaths in industrial than in rural populations. It was found that coal smoke quickened tuberculosis deaths in laboratorv animals and increased their susceptibility to pneumonia. The damaging effect on people was greatest in those industrial areas where humidity was high and fogs prevalent.

In surveys made of sootfall and respiratory disease rates in Cincinnati and Pittsburgh, there is a close relationship between high pneumonia death rates and heaviest sootfall. Although the evidence strongly suggests the presence of carcinogenic air contaminants in the smoky districts, the proof of its relation to human cancer is still not entirely settled.

Because the respiratory hazard is so much greater for men (50-90 percent) of the laboring classes than their wives, atmospheric pollution is pointed out as the responsible factor. (USPHS)


Mention is made of the effect on the eyes of continuous exposure to dust. (FA)

Consumption of smoked sausage for 2 years did not cause tumors in 20 adult rats. However, the wood smoke used for its preparation contained substances that were carcinogenic on subcutaneous administration in rats and on cutaneous application in mice. Of 18 female rats implanted subcutaneously with fragments of the skin from the factory chimney, three developed sarcoma, and of all 10 female mice rubbed on the back of the neck with an alcohol-extract of the soot daily for 2 years, one developed carcinoma and two sarcoma. No tumors developed in 18 male rats inoculated intrascrotally with soot fragments. (USPHS)

1947


After defining the nature, cause, and physical characteristics of a fog, a method for thermal dissolution of ground fog is described and the results of practical defogging tests according to this method are presented. (APB)


Experiments were performed with mice to determine the combined toxic action of carbon monoxide and benzene, such as might develop in those working in motor transport. The concentration, period of exposure, and temperature of air in the vapor chambers were noted. It was found that neither carbon monoxide alone nor benzene alone caused a very marked mortality at certain temperatures. But when animals were exposed to the two together the cumulative toxic effect was notable. A rise in temperature considerably increased the toxic action of benzene. The practical importance of these observations is great in view of the many cases of poisoning among those exposed to these substances. (APB)


A consideration of the volume of respiration and the normal functions of the lungs leads to a discussion of the effect of inhaled dusts, harmless, injurious, and toxic, with a brief note on explosive dusts. A section on arriage control is reprinted from a Bureau of Mines paper, and a summary dealing with local exhaust ventilation is from the Manual of Industrial Hygiene. (FA)


There is enough silica, tar, and sulfur dioxide in the air of most industrial areas to cause some degree of pulmonary fibrosis, to irritate the respiratory mucous membranes, and to predispose to respiratory diseases. There is a rising incidence of cancer of the lungs, the exact cause for which is unknown, although Robert Patterson blames it on road dust. Sunlight is greatly reduced by smoke, with a reduction in the feeling of well-being. Although obvious, the effect of this reduction is difficult to measure. Fogy periods tend to increase the deaths from respiratory disease and to increase the incidence of pneumonia and acute bronchitis in young and old. Death from respiratory disease appears to be markedly less in towns with relatively clean atmospheres than in highly polluted areas. (USPHS)


A form of pneumaticosis in which typical silicotic nodules were not found appeared in a boiler scaler. The lesions consisted of pigmented nodules. The black pigment consisted apparently of C for the most part, and Fe to a lesser extent. Samples from the whole lung (dry weight basis) contained 0.40 percent Fe (almost twice the normal maximum), 0.20 percent total silica, and 0.13 percent free silica. Previous analyses of boiler scale had shown amounts of free silica that were low compared with those usually found in industries accepted as having a silicosis risk: Fe, Zn, Cu, Pb, Ca, Mg, K, and Na salts have also been reported in widely varying amounts. (FA)


Experiments on the nasal penetration of particulate substances have been carried out on human subjects. Corn oil, sodium bicarbonate, and tricalcium phosphate have been used in this study on the effect of particle size and of flow rate through the nose. At 10, 17, 29, and 60 liters per minute the particle diameters corresponding to 50 percent penetration were found to be 8, 6, 5, and 3.2 microns, respectively, for corn-oil droplets. For sodium bicarbonate particles, at 60 liters per minute, the diameters for 50 percent penetration were found to be 2 and 1 microns. The tricalcium phosphate was heavily aggregated, but particles appearing to be unaggregated were counted. Using this as an index, the 50-percent penetration size at 17 liters per minute was found to be 4 microns. (FA)


There is a high incidence of cancer and other degenerative diseases in areas at outlets of navigable rivers and in low-washed-out valley lands; for example, industrial areas. Adequate smoke control would lessen the concentration in the atmosphere of airborne carcinogenic hydrocarbons caused by smoke and steam. (USPHS)


The effects of living and working in a smoke-laden atmosphere may be divided into (1) direct ill effects of breathing polluted air and (2) ill effects caused by reduction of effective sunshine. Comment is made on the incidence and activity from and mortality from pneumonia during and just after foggy weather and records made at Leeds and Glasgow are quoted. The power of smoke to absorb light is discussed and figures of Glasgow City Analyser are quoted for the amount of daylight and of ultraviolet radiation reaching the ground at Mearnskirk Hospital 7 miles to the southwest, and in the center of the city at Glasgow Cross. These figures show the great difference that exists between town and country stations in summer and winter. The importance of ultraviolet radiation which affects a synthesis of vitamin D in the body, is emphasized. (FA)


The first three chapters of this book discuss the nature of smoke, the seasons for its formation, and the extent to which it pollutes the atmosphere. Chapters 4 and 5 describe the consequences of air pollution as they affect the individual and the community. Chapter 4 is devoted to the effect of smoke on health. Considered insidious, but more important than other factors, is the loss of ultraviolet radiation. This tends to lead to a higher incidence of rickets, caries, and symptoms of other deficiency diseases. Statistics are cited to show the correlation between decreased sunlight with increased incidence of rickets, and pulmonary diseases.
The effect of polluted air on the respiratory system depends on physical characteristics, general health, conditions of the lungs, period during which polluted air is breathed, and the degree of pollution. Smoke does not produce a disease peculiar to itself but rather must be regarded as a contributory factor in diseases having other causative factors. For this reason, the examination of the effects of respiration of polluted air does not lend itself to isolated or statistical treatment. Moreover, much of the ill health for which smoke is probably most directly responsible, is in its early stages, not classified as disease, and is not included in any statistical records. The first and most common effect is the irritation by the polluting particles of the mucous lining of the entire respiratory tract. The reaction of this irritant is mucous discharge with resulting catarrh, sinusitis, coughing, and hawking.

In a consideration of heavily polluted air, as occurs with a dense fog, the situation is accelerated, and the respiratory system has to contend with abnormally severe difficulties. The acute irritation is due principally to the acid in the fog. The consequences are reflected in the increased incidence of illness and mortality. In cities where smog may be particularly severe, the rise in deaths in the wake of a fog is anticipated. Glasgow newspaper automatically allows more space for the object notices whenever there is a fog. The most remarkable statistical evidence appears at the end of the 19th century, when smoke pollution appeared to be at its peak. In 1873, there was a notorious smog over London, raising the death rate greatly. Another appeared in London in 1890. A 5-day smog appeared over Glasgow in 1900. It will be noted that the largest increase in the number of deaths occurs during the week following the heaviest fog. A fatality and bronchitis does not usually occur until a week or more after the onset of the disease. Post mortems of victims of the Meuse Valley disaster revealed in every case acute irritation of the respiratory system with death from heart failure. An investigation of the air of the Meuse Valley revealed the presence of nearly 30 impurities, most of which could be injurious or poisonous. There is no doubt that deaths and illness were due to the principal contaminants: sulfur and sulfuric acids.

The depressing effect of a smoky atmosphere is stressed. Everyone feels the stimulating effect of a fresh, sunny, summer morning, and few are the people who do not react the opposite to the depression of a smog pall.

There is no certain relationship proved yet with smoke-laden air and cancer.

The effects on plants are equally, if not more, injurious. The effects can be more adequately measured quantitatively and under conditions not possible with man or animal.

The effects of polluted air are shown by a stunting of growth, loss of vigor, reduction in reproductive capacity, degradation of color, and death. There are four principal ways in which these injuries are caused: (1) Sunlight is an essential factor in plant life and it is lost to the plants by the smog above and by the coating of soot on the leaves; and (2) the coating of soot on the leaves tends to choke the stomata through which respiration is conducted. This explains the fact that sunflowers are the first to succumb because of the characteristic sunk stomata forming an efficient trap for soot; (3) the sulfur acids in the soot are held in contact with the leaf, and some are probably absorbed through the stomata, causing damage to the living cell and destroying chlorophyll; and (4) sulfuric acid becomes oxidized in the soil, and the effects are then cumulative over the years.

Other sections of the volume are devoted to property damage and costs of air pollution. A separate section discusses the achievements in controlling air pollution. (USPHS)

1948


This report deals with the source, character, effects, and methods of control of atmospheric pollution. Smokes that result from the combustion of fuel contain soot, fly ash, and unburned or partly burned fuel. In excessive quantities, smoke is disagreeable, discomforting, and of economic significance, but the evidence so far collected has not been able to establish a definite relationship between smoke and health. Mucous membrane irritants include sulfur dioxide, chlorine, and phosgene. Eye irritants are acrolein, butadiene, chlorine, and hydrogen sulfide. (USPHS)


A report of investigations of the cause of the deaths of 17 people in Donora, Pa., and of 3 in Webster during the last weekend in October 1948 has been the most striking of actual proof of acute fluorine poisoning by the smog in the Monongahela River Valley of persons who had chronic fluorine intoxication. Most of the well-known symptoms of acute fluorine poisoning—"orange finger" by members of the medical profession who examined victims of the smog, Philip Sadler, consultant, discovered.

For 4 days, the fog bank across the tops of valley walls surrounding the towns had permitted little movement of air and allowed the gaseous waste products of several plants and the railroads to accumulate. Besides being saturated with soot, the fog blanket also contained sulfur dioxide, carbon monoxide, and hydrofluoric acid. It has not yet been shown that the first three were present in quantities sufficient to kill. Numerous factors, however, indicated fluorine poisoning, Sadler states. Fluorine-containing substances are used in several plants in the vicinity.

Analysis of the blood of the deceased and of hospitalized victims showed 12 to 25 times the normal quantity of fluorine. Corn crops, very sensitive to fluorine, were severely damaged and all of the vegetation north of the town was killed. One of the primary symptoms of acute fluorine poisoning in humans is dyspnea (distressed breathing similar to attacks of asthma), has been found in hundreds of cases. Although those who were affected were of all ages, those who died had displayed symptoms similar to those of chronic fluorine poisoning much earlier. Conspicuous evidence of such chronic poisoning in young persons in the vicinity is the high incidence of mottled tooth enamel and dental caries. Moreover, many effects of secondary fluorine poisoning are to be seen in herbivorous animals in the region. Lastly, laboratory animals show evidence of attack by acid gases.

Recommendations for improvements call for completion of the study to single out the plants, materials, and processes causing the trouble. Changes should be made in suspect processes to prevent emission of fluorine-containing fumes, and improvements in combustion are needed. Cottrell precipitators to collect dust and scrubbers to absorb the acid gases are also essential. (USPHS)


An experimental procedure for measuring lung retention of air-borne particles. The data are given in terms of the principal variable, the particle diameter. Suggests that there is a particle diameter giving minimum retention. (FA)
EFFECTS OF AIR POLLUTION

996. LEVITT, A. Smoke Abatement in the City of New York. Letter to William O'Dwyer, Mayor of New York City, dated June 1, 1948. (Min.)

Closely related to atmospheric pollution are such affections as tuberculosis, chronic illness, heart disease, cancer, arthritis, and diabetes. The cost of sanitation, decorating, and cleaning is also increased by air pollution.

Suggestions for adequate smoke abatement in New York include: (1) Enforce efficient smoke-control regulations, (2) burn smokeless fuel, and (3) inspect fuel and fuel-burning equipment and provide the necessary instructions. The successful smoke-regulatory program of St. Louis is cited. (USPHS)

1949


Presents a general review of the effects on health and a history of the subject. Discusses the present status of the administrative problem concerned. (USPHS)


Brief summaries of papers presented by various speakers at the first National Air Pollution Symposium (held in Pasadena, Calif., Nov. 10-11, 1949) cover such subjects as legislation over air pollution, costs of air pollution, effects on health as a result of loss of sunshine and irritation of respiratory organs due to air contaminates, and methods of determination and control of such contaminates.


Atmospheric pollution is a universal and complex problem. The two broad phases of the problem of effects and contaminants are analyzed. The effects are considered under the headings of nuisance, economics, vegetation, animals, and health. The contaminates are grouped as gases and vapors and particulate matter. The effects and contaminants are described briefly. The following methods of control of contaminates are discussed: Substitution, conversion, collection, and dilution.

Cooperative efforts of many groups will be required to arrive at reasonable conclusions that will permit industry to operate and the community to have an atmosphere essentially free of pollution.


Presents data showing that cases of chronic lung diseases from exposure to beryllium occurred in an appreciable number of cases of persons not connected with the industrial occupation. These people lived in the areas adjacent to beryllium-extraction plants. The data point out the findings of beryllium levels in the areas about the industrial plants. (USPHS)


The health hazards from chemical air contaminates that may exist more or less continuously in large industrial areas are assessed.

The true test of health hazard to the general public from any particular atmosphere is the ability of this atmosphere, when inhaled, to produce physiological deterioration in exposed persons, especially in those having respiratory or cardiovascular diseases. The methods employed in studying atmospheric contamination should concentrate on the measurement of deviations in respiration and circulation. Meteorologists, chemists, physiologists, and physicians can contribute to the solution of a problem that is becoming vital to our national health and economy. (21 refs. cited)


The health hazards from radiation produced by the explosion of an atomic bomb are discussed. (IHFD)


Some important matters to be considered in exploring the problems of air pollution are presented, and the people exposed are considered. There is much individual variation in the tolerance of persons to any kind of irritant, and there is considerable variation in the functional reserve, both respiratory and circulatory, with age.

Refers to community air pollution as causally related to cancer of the lungs.

Statistical analysis of properly collected correct data is the present basis for scientific belief and public information.


An attempt to assemble and interpret the available facts regarding the nature and extent of the common air-borne materials of industrial origin upon the health of persons who inhale these materials in the atmosphere of their communities. Such facts as can be brought to bear upon the subject directly or indirectly are derived from three principal sources. The most important source is that found in the literature of industrial toxicology, industrial medicine, and industrial hygiene; the second is the consciousness of large numbers of people of the problem of air pollution through certain extraordinary and dire happenings, such as those of the Meuse Valley in Belgium in 1930 and in the United States in 1948; the third source of information is the statistical correlation of the officially recorded incidence of the various diseases of man with apparent trends in atmospheric pollution.

These sources of information and their significance in connection with the problem of air pollution are discussed in detail. (6 refs. cited)


From the evidence thus far available, air pollution often contributes a nuisance, but, except under extremely unusual conditions, atmospheric contamination is not sufficient to cause specific disease or death. Aside from economic aspects the general well-being and comfort of a community may be seriously affected. Extreme care must be exercised in any attempt to establish direct causal relationship between air pollution and changing trends of diseases affecting the respiratory tract. It is true that in working with crude statistics certain data may be suggestive of possible relationship. In attempting to correlate changing trends in any disease with a given cause crude statistics do not suffice. In any given study it is essential to break down population groups accurately tabulated into age and sex categories and relate such data to a standard million. (IHFD)

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Presents a generalized consideration of air pollution of the community and its health aspects. Some of the sources are discussed, and it is shown that industrial stacks are not the only, and not even the main, source of air pollution, the chief contributors being autos, homes, and office buildings. It is concluded that common industrial poisons do not affect the general population through atmospheric pollution. The Donora and Meuse Valley incidents are cited as rare combinations of circumstances. The nuisance factor of air pollution, such as local mucous membrane irritation and extra blith, is mentioned. Examples are cited of the irresponsible opinions and papers injudiciously and unfairly written condemning air pollution for effects that have not been proved. (USPHS)


The effects are discussed of fluorides as pollutants of the atmosphere of open spaces and communities. Pollution of the atmosphere with fluorides as the result of industrial operations may contaminate nearby vegetation and produce chronic fluorosis among cattle eating thereon. Persons working in environments in which hydrofluoric acid is present have not suffered from irritation of the eyes or respiratory tract until the concentrations exceed 3 p.p.m. Any human discomfort or impairment of human health will not occur as a result of any general pollution of the air with compounds derived from present normal industrial operations. (13 refs. cited)


Excess atmospheric smoke leads to serious respiratory diseases. Smoke is related to many degenerative diseases and definitely contains chemical substances that contribute to cause certain types of cancer. Fly ash causes irritation and tissue changes in the lungs, and it is suspected that these lung changes predispose to pneumonia, tuberculosis, and cancer. It is known that, in areas polluted by coal smoke, respiratory diseases are of high frequency. Pneumonia causes six times more deaths in urban areas than rural. Chemicals released by combustion of coal are capable of producing cancer of the lung and other body tissues. Air pollution in New York has increased 40 percent in the past years, and cancer of the respiratory system has increased from 686 cases in 1930 to 2,000. It is asserted that the smoke-abatement program in St. Louis has decreased cost of upkeep of buildings, decreased electricity costs, and increased civic pride. Atmospheric pollution in Montreal and the program of smoke are discussed. (USPHS)


The authors have done a commendable job in compiling into a single volume what is known and much that is unknown on odors. The physiology of odors, their chemical constitution, classification, detection and measurement, and the chemical and health aspects, and methods of controlling odors in homes, public buildings, and industries are presented in an orderly manner in 23 chapters, with a well organized index at the end, which makes cross reference easy. Of special interest to industry are the last eight chapters of the book, dealing with a survey of odors made in the field, with the legal aspects of odor nuisances, and with practical methods for eliminating personal or public odor nuisances.

The book is well written, interestingly illustrated, and perhaps too fully documented with a 124-page list of references. It should be of value to industrial hygienists, architects, ventilation and air-conditioning engineers, members of the legal profession, and public-health workers in general.


During the smog period in Donora, Pa., from October 27 to 31, 1948, 42.7 percent of all persons in the area were affected to some degree and 20 persons in the area died during or shortly after the smog. The affection was essentially an irritation of the respiratory tract and other exposed mucous membranes, and varied in degree from mild (15.5 percent of the population) through moderate (16.8) to severe (16.4 percent). Both incidence and severity were directly related to age. Over 60 percent of persons 65 years and over were affected, one-half of them severely. There was no evidence of excessive inhalation of fluoride in the community. The general health of the people of Donora appeared no different from that of nearby towns, with the exception of such episodes as that of the smog. Such crises have occasionally caused higher death rates owing to cardiopulmonary complications. The autopsies of three persons who died during the smog showed acute changes in the lungs caused by capillary dilatation, hemorrhage, edema, parulent bronchitis, and bronchiolitis. Chronic cardiovascular disease, the origin of which antedated the smog incidence, was a prominent feature in the autopsies. A few domestic animals also died with illnesses resembling those of humans. Sulfur dioxide showed an even distribution over the neighborhood as did total particulate matter, except that it was highest near the zinc plant. Concentrations of zinc, lead, and cadmium were highest also in that vicinity. All concentrations were usually higher at night with greater air stability, except when otherwise affected by plant operations. Low concentrations of chloride, fluorine, and oxides of nitrogen were found in the general atmosphere. Sulfur was higher in particulate matter recovered at Donora during the smog than later. A combination of a high degree of atmospheric stability and stagnation probably was necessary and sufficient to cause an accumulation of airborne pollutants in the valley.

Local microturbulences within the valley at night appeared to distribute the particulate matter evenly throughout the valley. Similarity of average concentrations at all stations for various wind directions for sulfur dioxide, total sulfur, and total particulate matter showed multiple sources of these contaminants, whereas definite high concentrations of zinc and cadmium were found only downwind from the zinc plant indicating a single source for those elements. In general a greater percentage of higher concentrations was found in the wind speed range of 0—3 miles per hour, next highest at 10—22 miles per hour, and lowest in the 4—9 miles per hour range. The concentration of contaminants showed no significant relationship to relative humidity or temperature, but the relationship to atmospheric stability was very definite. No conclusions are drawn or documented in sufficient detail, although the following are ruled out: Fluorine compounds, chlorides, oxides of nitrogen, hydrogen sulfide, and cadmium oxide. Sulfur dioxide is discharged in significant quantities. However, "it appears doubtful that either sulfur dioxide or sulfur trioxide acting individually or together, reached levels that were capable of producing the syndrome." (IHD)


This report is based partly on air tests made toward the end of the episode in Donora, Pa. It is suggested that sulfur dioxide, found in appreciable amounts, was the cause of the illness. Morbidity and mortality studies were also reported. These indicated, through dental examinations, that fluorides were probably not the cause of the illnesses; and, through chest X-rays, that chronic pneumonitis did not occur in the community. The mortality studies showed that death rates from cardiorespiratory diseases were not unusually high in Donora. (USFHS)


Today it is known that air pollution embodies more than the smoke aspect, which was recognized first. Dusts, fumes, vapors, mists, and other contaminants that are emitted from industrial plants must be considered also.

To rid the atmosphere of the contaminants spewed into it by countless industrial operations calls for numerous and varied methods. An intensification of this problem can be expected as a result of constantly accelerating production.

The implications for the effects on health of atmospheric pollution are indicated by the dramatic episodes that occurred in 1930 in the Mense Valley in Belgium, where the heavy smog caused 69 deaths, and in 1948 at Donora, Pa., where 6,000 persons were affected, 20 of them fatally. Less dramatic episodes are the periodically occurring smogs, in other areas, for example Los Angeles, that cause disagreeable effects such as severe lachrymation and irritation of the nasal passages.

Methods of control of air pollution are already at hand. The challenge is to find cheaper methods of control. That is the task confronting the engineer. No other problem confronting the engineering profession demands more ingenuity, taxes all of its resources more, or is fraught with more responsibility for the health of the people.


In an area where 85 percent of the populace is reported to suffer from eye-irritating smog effects, it was not good news to have smog indicated as possible cause of lung cancer and death. Consultants reporting November 27 on a study of Los Angeles County, Calif., stated that from 1947-49 there were 312 excess deaths from respiratory and heart ailments in smoggy periods. Annual toll to county was said to be 104 excess respiratory and cardiac deaths on severely smoggy days, as compared to smog-free daily average. The California legislative committee studying the situation also heard that there had been a 30-percent reduction in smog in Los Angeles County in the last 2 years—but then wiped their smarting eyes as one of the year's worst smog attacks blanketed the surrounding section.


Questions concerning the causal relationship between air pollution and health require more complete knowledge of the qualitative and quantitative composition of the air breathed by men, than the identification of individual constituents or the determination of weight of the material that generally constitute the aim of the collection and analysis of the solide in the atmosphere.

This paper describes and illustrates the methods and equipment used by the authors in investigating atmospheric conditions in Cincinnati with respect to certain solid constituents, as well as the determination of a variety of gaseous pollutants.

The study is entering its fourth year, having expanded so that samples for the analysis of particulates are collected each month from more than 20 stations.


Atmospheric pollution is difficult to define. When an attempt is made to define a pure atmosphere confusion results. Air pollution is visible as well as visible impurities that are detrimental to the community, without defining the word impurity.

Reference is made to the fact that a substance, harmless in itself, when combined with another harmless substance, may produce a physiological action. Experience with the effects of air pollution at such places as Donora and Los Angeles is mentioned. Studies made at Pittsburgh are described indicating methods of collecting dust and analysis of samples.


Presents a general theory of physiological stress; the special nature is examined of the load produced by atmospheric contamination with chemicals and the response of human beings to this load. Residual effects observed in people in the Donora and Mense Valley episodes are discussed. The author stresses that the true test of a health hazard is whether any physiologic deterioration is produced in persons having respiratory or cardiovascular diseases.


A tradition that lingers in industrial hygiene is the belief that any harmful substance in the atmosphere acts solely through its own properties and in conjunction with no other substance that may coexist and which in turn acts only through its own specific properties.

In the case of atmospheric pollution due to smog, in its outstanding occurrences no one has been able to detect any level of any one substance conducive to the harm that manifestly has been brought about. At the same time, examining toxicologists may have reported the presence of 8 or 10 agents in trace quantities well below accepted dangerous levels. It then becomes pertinent to inquire if the possibility does not arise that two or more agents acting synergistically may be potent for the evil consequences. A somewhat dissimilar possibility presents itself in the concept that some one of several atmospheric constituents may serve as a trigger that imparts to one or more other elements a celerity or quality of action not known when present alone. The industrial hygienists, toxicologists, and pathologists proclaim that all such matters require evidence.

Evidence is not wholly lacking, but only one new item is proffered. The evidence presented is that of the effects of trichloroethylene and carbon monoxide noted in experiments on mice. Changes in the copresence of these toxic agents were induced beyond those acceptable in the absence of one or the other. This is synergism.

1018. Ishigami, R., Kikuchi, T., Fukase, M., Yamashita, Y., and Sawada, T. Observation on Both the Blood Picture and Bone Marrow in Atomic Bomb Sufferers in Nagasaki with Special Reference to Weight of the Individual Constituents. In the Blood; An Account of the Blood picture and Bone Marrow in Atomic Bomb Victims.
within a radius of 1 kilometer from the bombing center and in the districts of Nishiyama and Motohara Mura. Blood-cell data are tabulated.


Atmospheric pollution with fluorides from industrial operations may contaminate nearby vegetation and induce chronic fluorosis in cattle grazing on it. People working in environments in which HF is present have not suffered any irritation of the eyes or respiratory tract until concentrations exceeded 3 p.p.m. There have been no complaints from people who have inhaled larger quantities of fluoride than are likely to be emitted from industrial communities. Thus it appears unlikely that any human discomfort or impairment of human health will result from fluorides emitted from present normal industrial operations in the United States.


Although there are no industries in which oil fogs are a serious hazard and military smoke-screening of men with such fogs exposes them for only short intervals, oil fogs would seem to be potential hazards to men operating in oil refineries or working in currently screened areas. There is no information available concerning the toxicity of oil clouds for either animals or men. However, there are reports in the literature of approximately 200 cases of lipid pneumonia attributed to the inhalation of mineral oil, which attest to the dangers of oil accumulation in the lungs.

Mice, rats, rabbits, and monkeys were exposed for intervals varying between 100 and 905 consecutive days to fogs composed of oil particles in order that the possible dangers for men working in such atmospheres might be investigated. Ordinary automobile oil and S. F. No. 1 oil, the latter used by the United States Army Medical Corps for smoke-screening troops, were tested. Mice, rats, and rabbits were unaffected, and the occurrence of pulmonary tumors in a highly susceptible strain of mice was not accelerated by the oil fog. Surprisingly little oil accumulated in the lungs of the animals, and what was retained was rapidly transferred into the pulmonary connective tissues and lymph nodes. Lipid pneumonia was found not to be a hazard of living in atmospheres containing 63 to 132 micrograms of oil per liter of air because the low pulmonary retention enabled the phagocytes of the lung to engulf and remove it adequately. The incidence of infectious pneumonia in monkeys exposed to such fogs was greatly increased, although most monkeys so treated died with severe hyperplastic gastritis as previously reported.


The radiations that hit the human body were the following: Neutrons and gamma rays in the air (including the primary neutrons and gamma rays produced by the reaction between neutrons and nitrogen nuclei in the air), the radioactivities of the tissues of the human body and soil. The 1st Nat. Air Pollution Symposium held in 1949 had a discussion on the bombardment of neutrons (beta and gamma rays), etc. These all acted together, and the significance of each is complicated. Moreover, the scattering of gamma rays by the buildings differed very much according to the type of building and its location. So the total dose received by each person may have been different even when at the same distance from the explosion center or in the same building. The radiation intensity does not always decrease according to the inverse square law. Therefore, the factors affecting the total dose of radiation on the human body are very complicated and not easily calculated. In determining total dose by clinical symptoms, epilation is a rather accurate indication. However, the effect of protection by shelter, etc., should be considered, and its effect on the appearance of symptoms should be decided statistically. From the incidence of epilation the dose that was given to the human body can be estimated. Assuming the head epilation dose to have been 1,000 roentgens within 2 km., where 90 percent of all patients with epilation were located, it is estimated that the dose directly beneath the explosion center was from 10,000 to 15,000 roentgens. This also assumes the explosion center to be 500 meters above the ground and the radiant rays to decay by the inverse square law. Protection from the radiant rays of the atomic bomb afforded by caves, concrete walls, and building structures is discussed.


Refers to two dramatic episodes associated with atmospheric pollution having received widespread publicity, namely, the Meuse Valley (Belgium) episode December 1 to 5, 1930, and the Donora (Pa.) episode, October 27 to 31, 1948. In the Meuse Valley incident, 90 deaths were attributed to the fog, and in Donora 18 deaths were attributed to smog. These figures refer to deaths occurring only during the period of the smog. The very nature of these incidents was such as to create unusual interest. Questions were asked: What was the cause of the incidents? What was the possibility of a recurrence? What was the possibility of a similar occurrence elsewhere? Obviously, these questions are difficult to answer with certainty and cannot be answered fully without a great deal of investigations and research. Although precise answers cannot be given at this time, an evaluation of the principal factors may assist in a better understanding of the problem and its final solution.

It is evident from the official report of the Meuse Valley incident and from subsequent reports that the exact cause was not established beyond all doubt. In view of the complex nature of the problem and the lack of fundamental information, the phase of acute phase, a clearcut answer was hardly to be expected. Nothing conclusive can be said at this time about the Donora study because the analysis of the results is not complete. However, the study has served to emphasize areas of deficiency in present knowledge of the overall problem of atmospheric pollution.

Although the substances encountered were well known toxicologically, the data available pertain to acute effects or to effects on workers in good health and to exposures of 8 hours daily. When dealing with atmospheric contaminants, one must consider continuous exposure over many hours as well as effects on the aged, persons with impaired health, and hypersusceptible and allergic persons. Furthermore, available data are confined almost entirely to the effects of single substances. Little is known of the effects of simultaneous exposure to several toxic substances. The role that extremely fine particles may play by absorbing and transporting toxic gases or vapors to the alveoli is almost entirely unexplored. In addition to the direct action of toxic substances, the possible influence of atmospheric pollution on common diseases needs careful and critical analysis.

Recognizing these problems, the Division of Industrial Hygiene, United States Public Health Service, has planned to conduct investigations and undertake
fundamental research covering the entire field of atmospheric pollution. These plans include studies of the overall effects of atmospheric pollution; methods for determination and control of contaminants; correlation of weather conditions and dissemination, distribution, and dilution of contaminants; and toxicologic studies on animals.

Lack of sound scientific information has encouraged speculation and publication of uncritical and pseudo-scientific reports that serve only to confuse the issues, create hysteria, and precipitate hurried and poorly conceived programs that inhibit and delay orderly progress. These conditions emphasize the urgency of the need for fundamental studies to develop a sound basis on which to build progressive atmospheric-pollution-control programs.


The methods and results are given of certain preliminary experiments on the physiological effects on animals of the inhalation of sulfuric acid mist, droplets of which often contaminate the air in and around cities and industrial areas.

In these preliminary experiments animals were exposed to air containing sulfuric acid in the form of a mist, the particles of which were predominantly (about 95 percent) less than 2 microns in diameter.

Guinea pigs succumbed after having been exposed for a brief period to such a mist, the concentration of which was 0.086 mg. per liter of air (22.1 p. m.). Animals of other species survived after being exposed to this concentration for 2.75 hours, and much higher concentrations were required to kill them. When subjected to 0.549 mg./l. (140 p. m.) for 3.5 hours, some mice died, but exposure to 0.699 mg./l. (178 p. m.) for 7 hours was necessary to kill rats, and higher concentrations were required to kill rabbits.

Deaths occurred almost uniformly when groups of mice, rabbits, and rats were exposed to concentrations of 0.383 mg./l. (97.5 p. m.) for 7 hours on each of 5 successive days. After being exposed to a concentration of 0.265 mg./l. (51.7 p. m.) for a corresponding period, all mice, rabbits, and rats survived.

Rabbits were about as susceptible to the mist of sulfuric acid as they were to hydrogen fluoride, but guinea pigs were somewhat more susceptible to the former than to the latter.

Lesions resulting from the sulfuric acid exposures included degenerative changes of the epithelium of the respiratory tract, pulmonary hyperemia and edema, and, in some instances, focal pulmonary hemorrhages. There were, in addition, areas of both atelectasis and emphysema in the lungs of all animals. (Author's summary)


The great increase in incidence of cancer of the lungs that occurred between 1921 and 1945, particularly among town dwellers, may be due to the increase of carcinogenic bodies such as arsenic, 3,4-benzpyrene, and radioactive materials in urban atmospheres. Benzpyrene is present in coal tar, some lubricating oils, domestic soot, and sometimes in internal-combustion-engine exhaust gases. A survey of concentrations in the air and in smokes from power stations in London, a provincial city, and a town in a coal-mining area showed them to increase during the winter months. The most likely cause of the increase was believed to be domestic fires. It was concluded that the general level of benzpyrene increases, though only slowly, with increasing urbanization. (APB)


Describes a soot smog that rolled over a section of south Baltimore blanking everything it touched and making scores sick.

Dr. Wilmer H. Schulze of the city health department traced the trouble to a chemical plant in the neighborhood.

1951


The nature and prevalence of various forms of atmospheric pollution are examined and their effects on health, vegetation, combustion efficiency, etc. are discussed. Methods of measurement employed, limits of pollution allowable in various situations, and various factors affecting distribution and available means of reducing pollution are considered. Means of control now employed are described, and some suggestions are made to the end that the problem may be attacked more effectively.


One of the most unpleasant properties of mixtures of atmospheric contaminants known as smog is the irritation of the eyes, nose, and throat. Eye irritation, frequently accompanied by lacrimation, is perhaps the most outstanding characteristic in the smog occurring in the Los Angeles area. Although this property of smog has been studied for several years no single contaminant thus far identified in Los Angeles smog accounts for the eye irritation.

A study was made to determine the change in eye, nose, and throat irritation produced by systematically changing the composition of the artificially prepared mixture of several contaminants in concentrations found to exist in the smog. Methods of conducting the tests are described.

The following conclusions are drawn from the panel tests of artificial smogs. Although some of these conclusions are valid for artificial smogs, they only suggest what the Los Angeles smog may be like in these respects.

1. Atmospheres containing all of the major constituents of Los Angeles smog at the maximum concentrations at which these constituents have been found in smog produce definite irritation.

2. Removal of no single constituent of artificial smog eliminates all of the irritating action.

3. Removal of all of the particulate constituents had little effect on the eye-irritating action of artificial smog.

4. Removal of all of the gaseous constituents eliminates the eye-irritating action of the artificial smog.

5. The reaction products of ozone and gasoline at concentrations that one might expect to find in intense Los Angeles smog produce much less eye irritation than either the old-formula or the new-formula artificial smog.

6. The new-formula artificial smog, in which the hydrocarbons are reproduced by the reaction of gasoline and ozone, seems to have more nearly the odor of natural smog than does the old-formula smog.

It is important to note that intense natural Los Angeles smog seems to be more irritating than the artificial smog. The reason for this difference remains to be found. Two possibilities are that concentrations of certain contaminants are lower in the artificial smog than in the Los Angeles smog and that contaminants which produce irritation remain to be identified.

1028. DAUTERBADE, L., SHAPER, J., AND CAPP, R. [Studies on Aerosols XI. Influence of Particulate

The eye irritation produced by aerosols generated from formaldehyde, nitric acid, and sulfuric acid aqueous solutions at various concentrations, with and without particulate matter present in the air, was studied. The procedure adopted in the study, which provided a precise and easily controlled method for releasing, completely admixing, and conveying the contaminants to the ocular region, is described.

The eye, nose, and throat irritation observed in the Los Angeles area during smog days is due to the presence of particles or aggregates rather large in size (above 2 or 3 microns). As 10 percent of the material collected in the Los Angeles atmosphere has been found to be oily, the importance of oil aerosols is to be particularly emphasized in connection with the eye, nose, and throat irritation observed in the Los Angeles area during smog days.

However, the physiological and pathological importance of the constituent particles should not be minimized. From a public health point of view they probably have a greater importance than the larger ones as they may not be retained in the nose or upper respiratory passages, but may possibly induce chronic organic changes in lower parts of the respiratory tree. Experiments pertaining to the enhanced effects on the lungs of gases and vapors adsorbed on small-size particulate matter have already shown that this aspect of the air-pollution problem in Los Angeles and other industrial cities should no longer be neglected.


The Maryland State Department of Health asked the Public Health Service to join with it in considering how it might use a limited sum of money to evaluate the health effects of long-continued air pollution. The department of health had been charged by the State legislature, through the governor's commission on noxious fumes, to make such a preliminary study and report within a specified short period of time. It was decided that if data of some degree of validity were available on the condition of the environmental air of a community in the State, morbidity data, again of a limited nature, might be collected by making site visits to the families. It was found that such data on environmental air were available for one city in the State.

The city in question is typical of many river-valley cities in the United States. It has a population of some 40,000; it has a few large industrial plants and a large railroad yard, and about one half of the surveyed adults were employed in the plants or the yard. Bituminous coal is the fuel commonly in use.

Presents method used in studying air pollution in relation to human morbidity in detail. In the present instance the degree of air pollution was indicated by dustfall measurements.

Within the limits of this survey the data show that the frequency of the common cold was significantly greater in the high-dustfall areas than in the low-dustfall area and that this difference was not due to differences in socioeconomic status, age, sex, or occupation. The method presented, as indicated by the collected data and their analysis, suggests a procedure of studying the perplexing problem of the effects of air pollution on health.


A synthetic-rubber city grew up during World War II just outside Louisville. This large combination of plastics materials as calodol, acetone, butadiene, vinyl plastics, chloroprene, and Buna S and N rubber. From this group of plants and other industries within the area there has arisen a serious problem in air pollution, one which has periodically annoyed some 900 residents of the entire west end of Louisville. At various times, schools, churches, and even factories have been forced to dismiss persons for a session or a day on account of a severe eye irritation.

This air-pollution problem has reached such magnitude that its solution will require a long-range investigation and control program. However, the division has devoted a certain amount of its time and facilities to studying and controlling certain of the more serious phases of this problem, beginning with that of dust reduction inside and outside the carbide- and acetylene-manufacturing plant.

A method was developed whereby the hot gases from the carbide furnaces could be captured and suitably cleaned. Engineering tests show the efficiency of the system to be between 90 and 95 percent. The effluent solids from the 250-foot stack were found to be approximately 99 percent by weight.


The Supervisors of Los Angeles County, acting on recommendations of the Los Angeles County Medical Association, have established a Medical Commission on Environmental Contaminants to conduct research on the effects of smog on health in the area. A chairman and a secretary were appointed. Research specialists, three from each of the medical schools of the University of California at Los Angeles, the University of Southern California, the College of Medical Evangelists, and the California Institute of Technology, one from the research group of Cedars of Lebanon Hospital, Los Angeles, and the State director of public health, will comprise the members of the commission. The county medical association made the recommendation following a survey of 4,700 members, over half of whom believe that smog constitutes a menace to health.


Reviews literature on atmospheric pollution due to smoke. It is limited to smoke that occurs in urban communities and deals only indirectly with the many contaminants other than smoke introduced into the air by industrial processes.

The topics discussed are the epidemiologic problems, smoke as an agent of disease, smoke and human health, experimental studies, and appraisal of evidence.

The significance of atmospheric smoke pollution is to be found by weighing the damage done against any associated benefits and the cost and efficiency of any control measures. The balance may be struck in a variety of units—dollars, man-hours, death, or disease—and preferably in as many as are feasible, because it is not easy to establish their "rate of exchange." Initially some of the estimates may be appallingly crude and rough and possess a wide range of possible error, but only through increasingly refined estimates of total cost can a sound evaluation of smoke control, or of any other public health activity, be made.

It is concluded that smoke probably plays a major part in producing the illness and death that accompany fog. (95 refs. cited)


Introduction to a series of articles on air and stream pollution, which discusses what the problem is.
Health hazards of air pollution are of much greater importance than those of stream pollution. Although most air pollution comes from both natural and industrial sources, the physiological factors in air pollution are mostly derived from industry. The effect of air-borne contaminants on the body is discussed in detail.

The economic, public relations, and legal aspects are also discussed. (23 refs. cited)


The chemical industry should watch closely current developments in New York. There, an afternoon newspaper, notably successful in many and varied "scrapes" over the years, cast a disapproving editorial eye on air pollution.

The newspaper got its first big break when smog (the smoke control bureau refused to sanction official use of the word) settled over New York on September 12. The bureau and the city's health board were swamped with telephone calls from irate citizens, suffering from the atmospheric condition. The bureau could offer no explanation. Industry was not heard from. Then, more than 500 workers in the industrial area of New Jersey made ill by what was described as smog in the form of whitish haze. Later, the thick, acrid smog descended over the same area and over metropolitan New York, causing illness to scores more. The other daily newspapers in New York and those in New Jersey communities began to play up the story. The New Jersey State Commission on Air Pollution immediately began to investigate. Industry made no move.

Such campaigns may prompt the public to attribute every slight, unexplained illness to air pollution, and this can spread rapidly to other communities. Ill-advised, hastily drawn restrictive legislation, prepared by legislators under pressure from an uninformed, impatient electorate, may well follow. Unless industry throughout the country works quickly to counteract this trend, it may find itself being slowly strangled by such laws.


Fluoride emissions from the acidulating operations of a chemical corporation in Baltimore, Md., are controlled in the interest of the health, comfort, and well-being of the employees and of the people living in the vicinity of the plants. In some of the acidulating plants, a large number of long-service employees have been exposed to some fluoride concentrations for many years, but, in so far as has been determined, there have been no adverse effects upon the health of these workers. The concentrations of fluorides in the products today are only a fraction of what were once prevalent in this industry. It is believed that the small order of magnitude of fluoride emissions from the plants is in no way a health hazard to those living in the vicinity.

Methods used to control the fluoride emissions are described and illustrated.

1952


In a large chemical plant difficulties due to eye irritation were traced to a lachrymator formed by the interaction of styrene with chlorine and bromine in the atmosphere. Effective concentrations of these halogen may be much less than 0.01 p. p. m. (by volume) depending upon the concentration of styrene. Formation of the irritant in laboratory experiments was catalyzed by ultraviolet radiation and in practical circumstances seems to be dependent upon the presence of sunlight. (Authors summary)


The occurrence at Donora proves beyond any reasonable doubt that what has been commonly accepted as safe air pollution may, under certain meteorological circumstances, become a serious health hazard. Two sources of reliable information drawn on for this report were data collected by the staff of the Kettering Laboratory, University of Cincinnati, and U. S. Public Health Service Bull. 306.

Geography and general meteorological characteristics of Donora are outlined. The chief contaminants of the atmosphere were carbon dioxide, carbon monoxide, sulfur dioxide, dusts (carbon, iron oxide, and zinc oxide with traces of nearly every known metal), oxides of nitrogen, sulfur trioxide, and relatively minute traces of other gases.

The symptoms produced by the smog in decreasing order of occurrence in all ages are cited. The clinical picture of the disease, the pathological findings, and the present knowledge of the toxicity of the individual gases and dusts known to have been in the atmosphere make it quite clear that no single agent and no single source can be blamed. Nothing is known about the toxicity of mixtures of acid gases and dusts.


There is very little sound evidence at the present time to support the view (although it is assumed in general) that exposure to dusts and irritant gases may be a pre-disposing factor to acute respiratory infections, such as colds, bronchitis, and pneumonia.

Data obtained from studies of the health of persons who had been exposed to specific contaminants have not yielded any definite evidence that chronic exposures to low concentrations of chemical contaminants affect susceptibility to acute respiratory infections. Similarly the very few experiments that have been performed on laboratory animals have been chiefly negative. However, it must be recognized that the available data at present are entirely insufficient to draw any definite conclusions.

Fundamental research along the following four lines is needed: (1) Basic studies on the physiological effects of air pollutants on the body tissues; (2) animal experimentation on the effects of these substances on susceptibility to infectious diseases; (3) industrial morbidity studies in relation to known exposures; and (4) controlled epidemiological studies.


During the five days December 5 to 9, 1952, the greater part of metropolitan London was enveloped by smoke-laden fog, and there was a spectacular rise in deaths registered in greater London during the week ending December 13. The total was 4,706—more than double that for the preceding two weeks (1,902 and 2,062, respectively) and more than treble that for the corresponding period in 1951. Deaths due to "influenza" and pneumonia constitute a considerable rise from 58 in the week ending December 6 to 380 in the week of the fog. Remarkable too was the number of deaths from respiratory or cardiac disease referred to the coroners in London. The increase varied from twice to five times the expected seasonal number of necropes.
Informal reports from a variety of sources suggest that the duration and density of the smoke-laden fog could largely explain the dramatic increase in deaths from respiratory and cardiac disease in the middle-aged and elderly.

A study of the meteorological conditions in London at the time shows that high barometric pressure, low ground temperature, and high relative humidity, continued for the 5 days of the fog. Elsewhere in southern England similar observations were recorded, not necessarily accompanied by fog. Preliminary reports of the chemical analysis of the fog show that there was an increase in sulfur dioxide and in carbon content.

A number of investigations are now in progress; they include a detailed analysis of the deaths by age and cause as stated on the death certificate, examination of the reports of pathologists, a study of lung chemistry in certain fatal cases, and further chemical study of the fog and smoke.


After considering a number of air pollutants that affect teeth, especially in industrial air, the statement is made that detailed knowledge of industrial hazards to the oral structures is so scanty and the chance so great that the dentist can be a valuable scout for the medical team that no hesitation is felt in urging that dentists be included in all public health teams doing epidemiological work such as that done at Donora. The functional reason for having a dentist on the team is that he can appraise the level of nonoccupational dental disease in the area. (IHD)


Concentrations of lead and zinc in the general atmosphere are insufficient to cause lung damage. Beryllium dust has produced injuries only close to plants emitting large quantities. Combined irritants could not account for effects found after the Donora, Pa., and Meuse, Belgium, disasters. The theory of stress or "general adaptation syndrome" is considered (ABP).


A potential population hazard is well recognized where naturally occurring fog is contaminated by heavy industrial pollution. Available lists of contaminating agents include oxides of sulfur, cadmium, nitrogen hydroxyn sulfide, chlorides of hydrogen and zinc, fluorides of hydrogen and sodium, and a less suspected group of agents including carbon dioxide, carbon monoxide, arsenic, stibine, oxides of zinc, iron, and lead, as well as the free, carbon, and carbonate compounds. Studies dealing with acute effects are far more impressive than the amount of material available on chronic effects. An extension of research investigations to the area of chronic effects is greatly needed. Three specific goals should be: (1) A more systematic analysis of the basic physiology of long-continued low-grade chemical insult, particularly in the respiratory system; (2) an answer is greatly needed to the question of cumulative or associative chemical insult effects; (3) more needed directly at the constitution of the polluted atmosphere itself.


With the exception of soot as a possible cause of lung cancer and cancer of the scrotum, environmental cancer-producing factors pollution the air have only rarely been considered or investigated in connection with man. Studies of this problem that render valid evidence are very difficult, complex, and time consuming. At present all available data on this matter have suggestive value at best, and most are mere speculation.

Cancerogenic agents polluting the air may enter the human body by inhalation, skin contact, or ingestion. Exposure of the population to cancerogenic air pollutants, especially those of stable nature, may result from their subsequent incorporation into and contamination of drinking water, foodstuffs, and soil. Cancers caused by cancerogenic air pollutants may affect not only parts of the respiratory tract, such as the lung or nasal sinuses, but, depending upon the nature of the agent and the type of exposure, may affect other organs, such as skin, bone, and nervous systems, and bladder.

The future control of these potential hazards depends, first, upon the reliable qualitative and quantitative demonstration of cancerogenic agents in the air around establishments producing or handling recognized or suspected cancerogenic agents; secondly, upon thorough epidemiologic studies of cancer incidence in the population living in the fume or waste-disposal zone of such plants; and thirdly, upon the subsequent institution of effective measures preventing further release of cancerogenic agents into the environmental air.


The following points are discussed: (1) Air pollution of natural origin; (2) air pollution of artificial origin; (3) topographical and meteorological factors; (4) methods of study; (5) principles.

Direct and reliable evidence of the occurrence of injurious effects of a chronic insidious nature in our population, as the consequence of the pollution of the general atmosphere of our towns and cities up to the present time, except in rare occasions, is lacking, information being scanty, largely conjectural, and, in considerable degree, irrelevant.

The prevailing concentrations of the more common contaminants of urban and industrial atmospheres so far as information is available are well below the upper limits regarded as safe for men whose work involves daily exposure to these materials. Unfavorable meteorological conditions may retard the dissipation of the pollutants, thereby increasing their individual or compound concentrations to such an extent as to give rise to discomfort and even injury. Such effects have been of an acute character, and although they are of great significance in certain other respects, they appear not to have been characterized by persistent or residual injury or by chronic degenerative health.

Fragmentary information from a variety of sources points to the probability that chronic diseases of various types will occur with low but increasing frequency and perhaps with increasing severity in our general population, as the direct result of the pollution of the atmosphere of our cities with increasing numbers and quantities of new substances.


In the legislative approach to atmospheric pollution some reasonable relationship to facts is necessary. One of the first requirements is to get some idea of the
nature of air pollution. In the discussion of “What is pure air?” it is stated that the atmosphere has always been contaminated with materials that arise from the earth and from other bodies in space. From the hygiene point of view, the human race has had more grief from pollens and other air pollutants of natural origin than it has had from the total combination of artificial contaminates of the atmosphere. Some of these contaminants and their sources are mentioned.

Acute responses to sharply localized contamination of the air, which have occurred on numerous occasions, are cited. The fallacies are pointed out in the attitude of mind that holds that if a serious and acute effect results from exposure to a high concentration of a substance in the air, there must be some adverse effect from prolonged exposure to low concentrations of the substance.

In resolving the problem of air pollution two types of information are necessary—detailed determination of the composition of the air we breathe and the nature of the effects, if any, that are sustained by the entire population in breathing such atmosphere over long periods.

To the extent that there are satisfactory criteria of safety for the industrial worker, such criteria are applicable, in proper measure, to the community as a whole.


Discusses sources of atmospheric pollution and its effects. To elucidate the hygienic problem and to define the limits of necessary engineering control the following investigations are considered necessary: Determination of the atmosphere of representative industrial communities under a variety of conditions; exposure of animals to known concentrations and combinations of a wide variety of pollutants; and study of representative populations exposed to known conditions by epidemiological methods and by physiological study of selected individuals. (APB)


The relationship between air pollution and increased cancer incidence is briefly discussed and experiments with mice are outlined. Illustrates a filter for the collection of samples of smoke so that particulate and gaseous phases can be obtained simultaneously and independently. (APB)


On November 24, 1950, in the area adjacent to a recycling and sulfur-recovery plant of Petróleos Mexicanos at Poza Rica, Mexico, an air-pollution incident occurred which hospitalized 320 persons and killed 22.

The available meteorological data indicated a pronounced low-altitude temperature inversion, a high concentration of haze and nitrates, and a very slight wind movement prevailing.

The onset, the symptoms and signs, and the pathological findings are consistent with hydrogen sulfide poisoning, and there were no findings that conflicted with this diagnosis. Therefore, it is to be concluded that the hydrogen sulfide that caused this morbidity and mortality came from the effluent stack of the Girbotul unit. (AIHOM)

1049. McCaOn, CARY P. Properties, Physiology, and Psychology of Odors; chap. in Air Pollution, Mc-

The paper first discusses the sources contributing to atmospheric pollution. The paper then considers several constituents of smoke, particulate matter, liquid matter, and vapors and gases, considered in some detail and reference is made to sulfur compounds, fluorine, and carcinogenic substances. The next section of the paper deals with the environmental determinants, including the meteorological factors. (APB)


A relationship is indicated between the number of inhabited dwellings in a city and the death rate from cancer of the lung and of the bronchus in that city. The male lung-cancer indexes varied from 100 for cities such as London, Manchester, and the Mersyside group, with more than 200,000 occupied dwellings, to 134 and 152 for the Birmingham and Leeds groups, down to 100 for some 13 towns, each with 20,000 to 30,000 dwellings. The work of Doll and Bradford Hill "showed a remarkable preponderance of heavy tobacco smokers among the lung-cancer patients." This may serve to make much of the amount means to observe the correlation between high domestic smoke pollution and lung cancer. Much of the report appears conjectural, but it can be, and will be, tested by field research (AIHOM).


Four surfaces of man ordinarily exposed to air are: Minor—the eye and middle ear; major—the respiratory system (including lungs) and the surfaces of the skin. The extensive surfaces of the respiratory organ are designed to absorb gases from the air, and are in general much more permeable and delicate than those of the skin, which is constructed to prevent voluminous penetration of almost all things. However, some agents penetrate the skin more rapidly and readily than others — and some of these are toxic and some are allergic and can produce poisoning or reactions after skin absorption. Lists of substances are presented that have implicated or produced systematic poisoning via skin penetration. A variety of skin diseases are discussed that are directly or indirectly due to exposure to certain dusts, dyes, vapors, and gases in the air.

Dermatologists must not only continue but must enlarge their studies of the ways in which the physical and chemical constituents and properties of environmental air affect the skin and its reactions. (AIHOM)


Evaluation of the toxicity of any chemical must take into account, among other things, the effectiveness of body defenses, the length of time of action, and, particularly, the concentration of the poison that is inhaled, ingested, or absorbed. It is the concentration times the time of its action that determines the real hazard. Exposures to chemically active air pollutants are discussed, and a case is cited of a chronic lung disease that developed in 1942 as a result of exposure to zinc-beryllium silicate. The extent in the chemically active air pollutants is the chronic effects that may be produced as a result of inhaling relatively low concentrations over a long period of time. In the absence of proof of the chronic effects of chemically active air pollutants, experimental evidence, epidemiological reasoning, and epidemiological studies must provide the basis of our knowledge. Maximum allowable concentrations are a valuable guide. (AIHOM)


There is one area in the field of health effects of air pollution in which we can lay conjecture aside. Through the Meuse Valley and the Donora episodes, as well as the recurring Los Angeles smog, we can claim conclusive data on the acute health effects of air pollution. We can state unequivocally that air pollution can cause severe acute disabling disease.

In 1950 when the Meuse Valley in Belgium was blanketed by a heavy smog and 60 persons lost their lives, the study revealed that the effect was attributed to a single contaminant and its oxidation products and not to the total effect of all the contaminants. In the Donora, Pa. report, on the other hand, it was concluded that there probably was not enough concentration of any one substance in the air during the smog to have caused the illnesses, although considerable amounts of sulfur dioxide and its oxidation products, other gases, and particulate matter were emitted from the industrial plants as well as domestic and transportation sources.

Many questions are raised, and we cannot fail to be impressed by the fact that the necessary research in this field must be viewed as a long-range project and that the solutions will not come quickly.


Under certain conditions the inert substance inhaled fails to produce a significant anatomical change in the lung and does not interfere substantially with the immunological and physiological functions of that organ. However, it must be recognized that certain conditions may operate causing the inert substance to produce pulmonary change or to interfere with function. These conditions have reference to the physical character of the substance, its concentration in the atmosphere under varying degrees of temperature and humidity, the amount of substance inhaled and retained in the respiratory passages, the duration of exposure of the individual inhaling the substance, and, finally, the condition of the respiratory tract.


It is extremely difficult to distinguish the effects of chemical air pollution from those of organic dusts, as well as numerous other offenders. As is already well known, air pollution producing allergic effects on the respiratory tract is not confined to chemical contaminants, which may be partly controlled by local measures. Actually, the dissemination of organic material as fumes and particulate matter from the manufacture of animal oil, lead pencils (cedarwood dust), castor oil, malt, paint, paper, and stock feeds, as well as dusts from cotton gins, feed mills, flour mills, seed mills, or where there is storage or handling of grains are known causes of respiratory allergies.

Smut (parasitic fungi) infests such crops as wheat, corn, rye, oats, barley, sorghum, and certain vegetables that
abound in enormous quantities in the great Northwest grain-belt area) are responsible, in part at least, for some of the symptoms of hay fever and asthma occurring between and after the pollen seasons and for otherwise unaccountable exacerbations during the pollen seasons.

The report covers a systemic, long-range survey, which has been made for the past 17 years by the writer, of the common atmospheric mold, fungi, spuffs, rust, and allergic infections infesting the grains.

MAXIMUM ALLOWABLE CONCENTRATION

1915


Describes an experiment on 60 persons to determine what concentration of sulfur dioxide creates a nuisance. It is concluded that the average person is conscious of sulfur dioxide pollution at a concentration of 3.5 p. p. m. but that "trained" persons are conscious of such pollution at 2.5 p. p. m. Thus, sulfur dioxide is a nuisance to a community when its concentration is 3 p. p. m. or more. No mention is made of harmful concentrations and their effects. (USPHS)

1926


Automobile exhaust gases are mentioned but only in regard to poisoning due to high concentrations of carbon monoxide in these gases. Average of CO content given is 6 to 7 percent. Experiments by the Bureau of Mines showed that 0.04 percent CO was the maximum allowable for 1 hour's exposure in vehicular tunnels. (CLAC/UCLA)

1927


Concentrations of arsenic (as As_{2}O_{3}) up to 500 p. p. m. have been found in dust from the flue, and 150 p. p. m. in dust from the rain gutter of a factory—the source being the ordinary coal used as fuel.

One-hundredth grain of arsenic (the amount that should not be exceeded by, for example, that in 1 bu. of apples) is thus in 20 grains of such dust, which might easily be inhaled by a man sweeping such dust. As the m. d. of 2 grains would only be ingested in one-half pound of such dust, several cases of chronic ashenical poisoning might occur without a death to lead to detection of the cause. (DIH)

1931


Stress is laid on the increased danger from mixtures of gases and fumes as in exhaust gases from internal-combustion engines, fires, and explosives used in mines. Thus, mixtures of nitrous fumes and carbon monoxide developed from mine explosives or in the burning of X-ray films have been shown experimentally to prove fatal when the amount of each gas or fume inhaled singly will produce only slight symptoms. In experiments lasting 90 minutes, according to Wirth, inhalation of about half the mixture of the two gases proved fatal in a much shorter time than it would have with either gas singly. (USPHS)

1933


Results are given of daily sulfur dioxide determination in Pittsburgh, Pa., on the roof of the laboratory. Concentrations for the year ranged from 0 to 2.5 p. p. m. The highest concentration appeared during the morning. (USPHS)

1948


Sulfur dioxide is primarily a respiratory irritant, and as little as 0.001 percent may produce coughing. Slightly higher concentrations may produce conjunctivitis, pharyngitis, and bronchitis. The tolerable limit of sulfur dioxide concentration is 10 p. p. m. (USPHS)

1944


The hazards of gases arising from burning materials are described briefly. Combustion of nitrocellulose produces oxides of nitrogen; burning rubber produces hydrogen sulfide and sulfur dioxide; burning wool produces hydrogen sulfide, hydrogen cyanide, and ammonia; burning silk produces hydrogen cyanide and ammonia. The gases produced by combustible materials may cause fatalities even in the absence of serious burns. (USPHS)

1945


The table lists 156 contaminants, mainly organic, and concentrations are usually in parts per million. Columns A to F give values used in the States of California, Connecticut, Massachusetts, New York, Oregon, and Utah; column G, by the United States Public Health Service; and column H, by the American Standards Association. Column I gives values in both parts per million and in milligrams per cubic meter and C discusses each substance briefly, giving one or more references. The maximum for hydrogen fluoride is 3 p. p. m. Zinc oxide fumes are 10 mg. per m³. Silica dust is not listed. (FA)


Flue gas is discussed as the principal source of gaseous air pollution in cities. The principal contaminant of flue gas is carbon dioxide, of which the maximum concentration found in cities is 0.04 percent; this amount causes no known deleterious or objectionable effect upon either plant, animal, or human life. Most flue gases also contain carbon monoxide along with the carbon dioxide, and "carbon monoxide concentrations such as exist in even highly polluted atmospheres are not known to adversely affect either plant life, materials, or structures." Other studies have shown that traffic policemen are unharmed by carbon monoxide exposure. Carbon monoxide therefore presents no problem as an atmospheric hazard.

Although concentrations of sulfur dioxide in air over 1 p. p. m. will blight or kill vegetation, those below 0.2 p. p. m. cause no known damage to plant life. The generally accepted maximum allowable concentration of sulfur dioxide for human exposure is 10 p. p. m., which is considerably higher than any atmospheric concentration yet recorded other than in the direct wake of gases from a particular stack. It is conjectured that a concentration of 40 p. p. m. was reached in and 1930 Meuse Valley disaster. (USPHS)

1946

Shows that the usual method of specifying the total solids per cubic foot of gas, with or without size restrictions, does not give a fair picture of nuisance value and proposes a method depending on settling rate. A suggested ordinance reads: "The amount of dust having a settling velocity of * * * feet per minute or greater which may be emitted from any stack shall not exceed * * * pounds (or other unit) in any 1 hour for each foot of stack height above grade squared." This method has the following advantages: (1) It regulates the amount of dust in terms of its nuisance value; (2) it considers the stack height as a factor; (3) it takes setting rate into account; (4) it applies to all types of dust; (5) it creates no new problem for the manufacturer of equipment; (6) it permits regulation of plants emitting dust for limited periods; and (7) it simplifies the establishment of violations. The elutriator provides a simple method of measurement. (APB)

1947


At the first meeting of the Subcommittee on Standards for Dust Emission From Chimneys, of the Smoke Prevention Association, held at St. Louis on June 24, 1947, it was decided to outline the problem. The committee agreed to begin with stack solids resulting from combustion of solid fuel, but its scope should not be limited to that class of emission. It intends to set maximum allowable dust emissions that can be applied to a variety of dusts, to determine the units in which to express those limits, and to provide an effective standard test method that can be used to verify compliance or noncompliance. (FA)


Rarely do the ascertainable facts establish that common atmospheric pollutants are hazardous to health in the sense that demonstrates ill health results from inhaling polluted air. Sulfur dioxide is one of the chief contaminants; plants should be so operated that the concentrations do not exceed 0.5-0.75 p. p. m. A table shows the general classification of pollutants according to outstanding physical properties. (USPHS)


Experimental data on diffusion have been accumulated for many years at the Chemical Defense Experimental Station, Porton, Wiltshire. The mathematical theories developed at Porton are applied to the problem of the distribution of smoke and gases from sources elevated above the surface, and the Porton data are used to obtain numerical values. The maximum concentration of smoke at ground level from a chimney of height h is found at a point where the distance downwind from the chimney base increases rather more rapidly than the height of the chimney. The maximum concentration itself varies inversely as the square of the height of the chimney. The results apply to average conditions, defined as those associated with small vertical gradients of temperature. When large lapse rates do exist (as on warm mornings in summer), the turbulence of the air is greatly increased, and the cloud is diffused more rapidly in all directions; that is, in general, smoke will be found nearer to the chimney base; at a lower concentration. When a surface inversion forms (as on a clear night) the smoke tends to drift away from the chimney in a much more compact cloud, so that the point of maximum concentration at ground level will be displaced farther downwind, but concentrations will be higher everywhere and will fall off more slowly with distance. Industrial atmospheric pollution can be reduced primarily by (1) high stacks, where noxious fumes are emitted, and (2) some method of meteorological control. (APB)

1948


Discusses factors to be considered by safety officials in applying current permissible tables and reviews the history of such standards. (APB)


The composition of exhaust gases and their toxicity depend upon a number of variable factors, but CO is the principal deleterious constituent that occurs in toxic concentrations; others (unsaturated hydrocarbons and aldehydes) are present in too small proportions to affect health. With increasing motor traffic, the toxic concentration of CO may spread beyond the line of traffic to the vicinity of main roads. Indirect effects also must be considered, for example, absorption of ultraviolet rays and sunlight, disagreeable odor, which favors superficial breathing, etc. The remedy lies in (1) insuring the most complete combustion possible by proper engine design, adjustment of carburators to prevent mixtures with frequent inclusions and overhauls, especially of nozzles, use of high-grade fuel with frequent quality and purity tests; (2) exercising care in avoiding fuel and exhaust leaks and smoke due to oil splashes, insuring proper compression, fitting tractors, buses, and trucks with gas absorbers and ejectors having outlets 6 to 8 feet above ground level; (3) regulating traffic to concentrate main flow over wide roads, with pedestrian traffic at a safe distance, keeping traffic, garages, etc., away from narrow streets and congested districts, and authorizing suitable official control to insure observance of all these points. (APB)

1949


Some of the highlights of the problem of atmospheric pollution are considered briefly, and the importance of the problem is emphasized. In discussing the maximum allowable concentrations, the author observes that the concentrations established for workers are too little light on the amounts that can be breathed 24 hours a day by the general population, including the very young and the aged, as well as persons with organic diseases and those especially sensitive to respiratory irritants. He emphasizes the fact that information available on the toxicological effects of mixed-irritant gases is meager and that data on possible enhanced action due to adsorption of gases on particulate matter are limited. (IRHD)


Atmospheric impurities can be tolerated safely at concentrations that vary with the toxicity of the compound. Only a few substances, like carbon monoxide, having such well-defined systemic effects that exposures can be defined with a high degree of precision. Most others, like benzol and carbon tetrachloride, fit best into zones of toxicity. Six such zones are given for a number of representative substances among the least harmful, like acetone, at concentrations of 500 to 2,500 p. p. m., to the extremely toxic, like radon gas, at concentrations below 0.1 p. p. m. This classification of contaminants should be of practical value in understanding and controlling industrial health hazards. (FA)
Problems that confront hygienists and toxicologists in tackling air contamination are discussed. It is believed that hygienic limits are desirable, and "bases" for air-pollution control standards are advocated.

A concentration of an atmospheric contaminant that may be encountered up to 24 hours per day, or 24 hours per week, must be considerably less than one encountered only during a workday.

Because so little is known about outdoor air pollution, benchmarks or standards should cover only local areas until enough data are collected to justify national standards.

Studies on the meteorological factors influencing air pollution, the technical aspects of the smog problem, and the nature of industrial dusts and fumes in the Los Angeles area demonstrate the necessity for limiting the amount of pollution entering the atmosphere from industrial and other sources. The Los Angeles County Air Pollution Control District and the industries that release the dusts and fumes have studied the nature and quantity of materials that contribute to air contamination. From these studies dust and fume standards have been developed. The concept of total process enthalpy led to the use of total process weight as a basis for establishing the weight of solids that may be released in the atmosphere. It simply and effectively limits the amount of solids discharged, making it unnecessary to consider dilution in control standards.

The collecting efficiencies used were those that can be obtained with commercial equipment within the economic reach of industry. The average collecting efficiency required of small industrial units is approximately 80 percent; of large industrial plants, approximately 90 percent. (4 refs. cited)

The standardization of permissible air contamination has proved to be a difficult task for the following reasons: (1) Scarcity of data on physiological effects; (2) reluctance of committee members to accept definitive figures because some States will fix them in their codes; (3) fear that unnecessarily high limits will be set; and (4) the inability of committee members to reconcile their viewpoints. A committee in harmony on the general purposes and interested and qualified in industrial hygiene and toxicology is urged. The following suggestions were also made: (1) The term "maximum allowable concentration" should be replaced by "permissible concentration of air contamination," "safe practice standard," "hygienic standard," or some similar term; (2) a range of concentrations should be used as standard instead of a definite concentration; (3) a rare and reversible condition should be attempted rather than the improbable goal of complete eradication. Standardization on the basis of physiological effects is difficult because side factors such as nutrition often play a part. In some instances permissible limits may be based on nuisance value and in others on sound engineering practice. Every standard should clearly indicate its basis. Standards based on explosion control are simple and easily established. Standards for outdoor pollution are infinitely harder to fix than indoor standards. (IHD)

1959.


Atmospheric pollution by chromium compounds was investigated in the vicinity of a plant producing chromium compounds. The ground-level concentration of chromium at various distances leeward of the plant is reported. It was found that the exhaust air, which discharged to the out-of-door atmosphere through 12 stacks ranging in height from 62 to 78 feet above ground level, contained chromium, sodium monochromate, and bichromate.

A knowledge of the degree of exposure of persons residing in the neighborhood of such a plant is one of two essential steps necessary to ascertain if a relationship exists between exposure to chromium and epidemiological evidence of cancer.

The apparatus used to collect samples of the atmosphere is described.

Orthogonal decontrol of the sampling apparatus from the cloud axis, due to shifting winds, was experienced. As a result, it is believed the values reported are low. Strength of source, wind velocity, and cloud diffusion were not measured; hence, no adjustments have been applied to the experimentally determined values to compensate for these variables. In the absence of previously published information on atmospheric pollution by chromium compounds it is believed the findings reported are of value notwithstanding the limitations encountered (8 refs., cited).

1958.


Some general considerations of industrial health and hygiene are discussed. Definite opinions are expressed on various major and minor phases of industrial hygiene. First, the reluctance of some hygienists to set limits for pollution is criticized. There is sympathy for such timidity. If you are practicing industrial hygiene and refuse to state what conditions should be attained, you are simply evading your issues." Standards of pollution should be set and will be set for the atmosphere in the neighborhood of industries causing pollution. (IHD)

1958.


The problem of atmospheric pollution resulting from the release of diesel- and gasoline-powered truck and bus exhaust gases is discussed. Of the many compounds found in engine exhaust gases, the most important with respect to air pollution is carbon monoxide, aldehydes, and possibly sulfur compounds. In general, the concentration of carbon monoxide decreases and that of aldehydes increases as the air-fuel ratio to the engine increases. Carbon monoxide concentrations ranging from zero to 310 p. p. m. have been observed at busy street intersections. The maximum allowable concentration for carbon monoxide, based on an 8-hour exposure, is 100 p. p. m. Tests indicate that aldehydes are probably responsible for the offensive character of diesel exhaust gases. Concentrations up to 50 p. p. m. have been found in these gases. Appreciable concentrations of aldehydes have also been found in gasoline-engine exhaust when the air-fuel ratio was abnormally high, that is, during deceleration with the throttle closed when the momentum of the vehicle drives the engine. Increasing the air-fuel ratio will decrease the amount of carbon monoxide produced by the engine and increase the supply of oxygen for more complete combustion. This will increase the amount of aldehydes produced, but the author suggests that these may be efficiently removed by the use of a water scrubbing device. Such a device is described and illustrated in the article. (PHEA)
The Los Angeles air-pollution regulations as amended April 1949 call for a “mass rate” standard of air pollution, according to which the total allowable discharge should in no case exceed 40 pounds per hour (from 30 or more tons processed per hour) and is graduated from there down to 4.14 pounds allowable discharge from 1 ton processed. The gray-iron foundry industry consists of 54 small operating foundries. Three tests were made as typical cupola type furnaces. These tests show that the loss of the particulate matter is in every instance much greater than the total allowed loss, although the harmful constituents listed are well below their respective maximum allowable concentration. In an attempt to remedy this condition several types of air-cleaning apparatus embodying the best recommendations of their manufacturers were applied. They included wet scrubbers and bag collectors, and an electrical precipitator preceded by a wet scrubber was to be tried at the time of publication. Other processes are to be tried as they develop, but the conclusion reached was that at present there is no known collector that will solve the problem and still be within the economical limits of the foundries.


Calls attention to the report of a subcommittee of the Air Pollution and Smoke Prevention Association of America, which is outstanding because of a different attack on the problem of setting a standard for dust emission from boiler-plant stacks.

The committee proposes that every plant limit its dust discharge to the smallest practicable quantity. To require more would not be reasonable. If, while doing the best that can be done at the existing state of the art, the plant still creates what the community considers to be a nuisance, then the community should decide to live with the nuisance or to pay the cost of eliminating it.

The committee has chosen to vary the dust limits according to plant size. This permits weighing the cost of air-pollution prevention against total cost of plant. It requires each size of plant to conform to the highest standards practicable for it, that is, each plant must do the best that can reasonably be expected of it.

The committee proposes to take account of plant size by tying solids emission, in pounds per hour, to steam generated—the average hourly output of all units connected to any one stack for that continuous 4-hour period during which average output is greatest. Output is expressed in terms of steam containing 1,000 B. t. u. per pound. Soot blowing and collector rapping are allowed for by permitting the stated limits to be exceeded for a total of 2 hours during any 24-hour period.

1952


A chart shows concentrations in grams per m. on a logarithmic scale ranging from 10^0 for low-pressure pneumatic conveying down to 2.4×10^-8 for threshold limits for radioactive elements and including coal dust, fly ash, and mine, city, and country air. (APB)

MORTALITY AND MORBIDITY

1882


Air impurity has a deleterious effect on health through the reduction in oxygen content as well as the clinging of the lungs with impurities, which reduces their power to absorb oxygen. This impure air arises from the “dust of refuse, mostly horse manure, as well as from smoke, and other products of combustion.”

The influence of smoky town air on health is to some extent illustrated by the fact that the death rate of 23 manufacturing towns, selected chiefly by their smoky character, averaged 21.9 per 1,000 in 1880, while the rural districts in the counties of Wilts, Dorset, and Devon averaged 17.15 per 1,000; the deaths from the principal gynetic diseases in the towns were more than double those in the rural districts. (USPHS)

1891


Manchester is still conspicuous for its high mortality, especially for its excessive death rate from tuberculosis, pneumonia, bronchitis, and heart disease. All forms of septic disease are unduly prevalent. The windows of houses and factories are closed on account of the dirt which enters by the open window. Less attention is paid to cleanliness than is required for health. Fresh air is needed not only in the treatment of patients but is equally necessary in raising healthy children. The mouth breather is at a much greater disadvantage in Manchester than he is in the country, and it is important that adenoids are attended to. (USPHS)


In 1891 an increase of death rate was noted with the heavy London fog. (USPHS)

1892


Whether inhalation of smoke is unhealthy was discussed before the society at the request of the Health Association of Allegheny County, Pa. Exception was taken to the statement that “There is nothing particularly unhealthy about smoke,” made at an earlier meeting of the Society.

In support of the contention that inhaling smoke was unhealthy death rates for two periods—one of 8 years when coal was universally used and one of the 8 years when natural gas was used—were compared. The death rate during the latter period was reduced 1.62 per 1,000, a considerable reduction in favor of the comparative nonsmoke period. During a 5-year period when gas was cheap the death rate was 19.58 per 1,000 compared with a death rate of 22.15 per 1,000 for a 5-year period when gas was high and less generally used—a difference in favor of the cheap-gas period of 2.57 per 1,000.

1907


The discussion deals mainly with mortality from pulmonary diseases other than tuberculosis. Observations tend to the conclusion that smoke increases the incidence of acute pulmonary disease and that it hastens the course of tuberculosis. Tuberculosis-infected rabbits which inhaled coal smoke died in an average of 53 days. Those infected with tuberculosis but not exposed to the smoke died in 90 days.

For the city of Manchester the number of foggy days dropped from 36.8 for the years 1896-1900 to 23.4 for 1901-5. A corresponding decrease in mortality from acute pulmonary disease, especially in children under 1 year, was observed. Statistics for urban and rural districts for the period 1902-4 show that mortality from acute respiratory disease is higher in cities than in rural areas. Smoke, however, aggravates acute pulmonary diseases. Other influences are climate, living conditions, and harmful organisms. The death rate...
is higher from respiratory disease for industrial workers in smoky atmospheres than for rural agricultural laborers. It is 26.2–65.6 per 1,000 living in industrial areas and 18.6 per 1,000 for those living in agricultural areas. (USPHS)


There was an increase in mortality due to bronchitis and pneumonia until 1885 and a considerable decrease since then, according to the 66th Annual Report of the Registrar General of England. A decrease in smoke since that time is reported. According to the medical officer at Manchester, the number of fog days and the mortality rate from acute pulmonary disease have dropped.

Statistics show that smoke causes a predisposition to acute pulmonary diseases and accelerates the course of pulmonary tuberculosis. It also was found that in humid atmosphere coal dust was aspirated in larger quantities than in dry weather. Tuberculous guinea pigs, exposed to a moderate amount of smoke, died of pulmonary tuberculosis sooner than those with smoke-free lungs. (USPHS)


The disadvantages of smoky fogs are listed as reduction of light; damage to buildings, decorations, and property of all kinds; expense from disorganization of traffic; loss of life; and injury to health and impaired vitality. During the winter fog of 1879–80 deaths were several thousand above normal, the percentage increase being 43 for asthma, 331 for bronchitis, and 251 for whooping cough; in the last fortnight of 1881, including the 100–hour fog at Christmas, the excess above normal was said to be 1.442.

Methods of abating the smoke are discussed. Prolonged black fogs do not occur in Paris, Berlin, or New York owing chiefly to the difference between the modes of heating and those of England. 1909


In 1907 Chicago reported 32,000 deaths. Of these, 9,000 were due to what is termed "bad-air diseases"—consumption, pneumonia, bronchitis, and influenza. Of these, 4,900 were due to pneumonia, 3,700 to tuberculosis, 500 to diphtheria, and 376 to typhoid. In 1908 some improvement in impure air diseases was made by the air-pollution control activity, the smoke commissioner, and the Health Department, as well as by industry. The carbon in the air resulting from improper combustion is virtually harmless but the sulfur dioxide is believed to be harmful. (USPHS) 1913


Statistics given for 1900–11 show the relationship of the tuberculosis and pneumonia death rates with smoke content of the air, with particular reference to Pittsburgh. A map of Pittsburgh is shown, dividing the city into wards, and the average density of the smoke is shown by various densities of shading. A graph depicts the pneumonia death rate and smoke content of the air by wards. Another plots similar information for the tuberculosis death rate and smoke content of the air by wards. The pneumonia death rate and smoke content of 15 cities of the United States are compared. The correlation of death rates from pneumonia and smoke content is striking in Chicago, where the smoke content was comparatively low and yet the pneumonia death rate was very high. In the various cities smoke content was based on the distance of vision, using standard observation equipment. In Pittsburgh, carefully devised studies of precipitation of air content of carbon dust served as the criterion.

The conclusion was reached that smoke is a very important factor in the unusual severity of pneumonia, as encountered in Pittsburgh, and that some other factor must operate in those cities where the smoke content is comparatively low and the pneumonia death rate is still high. Also no correlation was found to exist between smoke content of the air and the tuberculosis death rate. (USPHS) 1914


The work of Ascher is considered as the most comprehensive study of the direct effect of smoke upon the respiratory organs. Ascher has published several monographs dealing with the subject both from the standpoint of vital statistics and animal experimentation.

He uses statistics to show the increase in pulmonary deaths in industrial areas. He also gives statistics indicating the fallacy of the belief that miners are relatively immune to tuberculosis. A miner is an invalid at 40 and dies of an acute pulmonary condition. Miners die from acute disease before tuberculosis can take over. Also, mortality due to tuberculosis is not low among laborers working in coal dust and smoke. Coal carriers, chimney sweeps, and soot handlers have a high tuberculosis mortality. The low mortality from tuberculosis among coal miners is due to the choice of workmen especially fit for hard work and to good social conditions because they earn a higher scale of wages. Thus, Ascher blames smoke particles for the high incidence of acute respiratory conditions and believes the claim of immunity in workers to tuberculosis is erroneous. (USPHS)


As part of the study of the smoke problem in Pittsburgh, carried out at the University of Pittsburgh, the influence of varying densities of smoke on the mortality from tuberculosis and pneumonia was investigated. The conclusion was reached that the smoke content of the air apparently has an important bearing on the pneumonia death rate but has comparatively little bearing on the tuberculosis death rate. 1924


In a study of mortality from respiratory diseases for a 27-year period in two areas in Great Britain it was found that foggy days associated with low temperature showed the highest mortality from respiratory diseases. No increase in mortality rates from these diseases was noticed when fog existed with relatively high temperature. (It is to be observed that the term "fog" as used in this report is probably a combination of fog plus air pollutants of an industrial nature.) (USPHS) 1926


The polluted atmosphere is considered an important contributory cause to the high death rate from respiratory disease in Manchester, England. Every inhabitant
living in the center of the city dies 10 years younger than the general average, chiefly because of the polluted atmosphere. The irritant effect increases susceptibility to tuberculosis. Statistics are given to show the high rate of all deaths from respiratory disease in particular, in congested industrial areas where smoke pollution is greatest. (USPHS)


This is a most excellent summary of useful facts. It deals with Manchester throughout and gives, first, the impurities that are deposited upon it from the air annually:

<table>
<thead>
<tr>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash</td>
</tr>
<tr>
<td>Soot</td>
</tr>
<tr>
<td>Sulphuric acid (210,000 gallons)</td>
</tr>
<tr>
<td>Tar (16,000 gallons)</td>
</tr>
<tr>
<td>Dissolved in rain</td>
</tr>
</tbody>
</table>

Total, which is 6 times that at Timperley, 6 miles distant 20,180.

There follows a quinquennial analysis and comparison between the death rates of the inner area of Manchester, with 28 persons per acre, and the outer area of approximately equal size, with 76 persons per acre. Taking the death rates of the outer area as 100 percent, the inner area had:

- 55 percent excess in total death rate (10.5 to 16 per 1,000),
- 29 percent excess in infant mortality rate,
- 57 percent excess in deaths from measles,
- 52 percent excess in deaths from diarrhea,
- 44 percent excess in deaths from pneumonia,
- 43 percent excess in deaths from whooping cough,
- 42 percent excess in deaths from bronchitis,
- 49 percent excess in deaths from pulmonary tuberculosis,
- 51 percent excess in deaths from nonpulmonary tuberculosis,
- 14 percent excess in deaths from scarlet fever,
- 19 percent excess in deaths from diphtheria.

The special significance of the two last items is that all cases were treated in the same hospital. Finally, the information given shows that if the daylight at Timperley (some 6 miles south of Manchester) is taken as 100 percent, the daylight at Manchester ranges from 150 in north winds to 55 percent on still days or 5 percent during fog. (BH)

1928


The remarkable reduction in enteric diseases is considered a mark of success in efforts at improved sanitation. The high rate of respiratory diseases will continue until the fogginess is removed from the atmosphere.

Average mortality figures for bronchitis, pneumonia, and other respiratory diseases from the years 1921 to 1925 are given for various British communities. Areas in which deaths from bronchitis are more than 50 percent greater than that of England and Wales as a whole are indicated. Among the highest were Manchester and Salford, which are noted for their heavy smoke pollution, dampness, rawness, and relative absence of sunshine. Domestic tarry smoke is indicated as the chief offender.

Local doctors commonly find their bronchitis patients dying off in numbers during prolonged periods of winter fogs. In the report of 1923 charts were produced showing a close relationship between periods of winter fog and deaths from respiratory disease. There is little doubt that a smoke-polluted atmosphere is responsible for much of the nasal and bronchial catarrh that is prevalent.

An indirect but serious effect of smoke is loss of sunshine. Such loss leads to increased incidence of rickets, anemia, and tuberculosis and to interference with normal growth.

In 1926 the general death rate was the lowest ever recorded at Salford, and the biggest reduction was in deaths due to respiratory diseases. This fact is correlated with the prolonged coal strike and the consequent relatively pure atmosphere for that year. (USPHS)

1931


The report of 63 deaths in the Meuse Valley incident is discussed. Most of those who died were elderly and many of them already suffering from cardiac and pulmonary disorders. Other factors to be considered were a dirty fog and bitter cold weather. However, death came quickly, suggesting poisoning, and at autopsy the lungs showed irritative changes consistent with the inhalation of sulfur dioxide. (USPHS)

1935


Statistical evidence indicated a close relationship between death rates and atmospheric conditions. The number of deaths from lung and heart diseases increases in direct proportion to the intensity and duration of fog smoke. As an example, Glasgow is cited with 75 deaths before the fog, 135 during a 3-day fog, and 233 in the week following the fog. (USPHS)


Statistics show a close relationship between death rates and atmospheric conditions. The number of deaths from pulmonary and cardiac diseases increased in direct proportion to the intensity and duration of smoke fogs. Tuberculosis of the lungs is aggravated. Tarry matter of smoke is suspected to cause cancer. Psychologic ill effects were interrelated with the physiologic. Smoke screen lessened the potential reserve, working power, and well-being of the individual. (USPHS)


Causes of smoke, measures taken for its reduction, methods of producing smoke, atmospheric-pollution investigation, and the effects of smoke on health are discussed. Statistical evidence shows a close relationship between death rates and atmospheric conditions, the number of deaths from pulmonary and cardiac disease increasing in direct proportion to the intensity and duration of smoke fogs. In November and December 1909 Glasgow is reported to have had 3 periods of dense smoke fogs. Deaths from respiratory diseases during the previous week totaled 75; during the week comprising the first period they reached 138; and in the ensuing week they rose to 233. Over the whole period of bad fogs the death rate from respiratory diseases rose from 2.1 per 1,000 to 15.0 per 1,000, an increase of 11.8 per 1,000, while in seven other towns where fog was free during the same period it rose from 1.4 to 4.8 per 1,000, an increase of only 3.2. If the Glasgow death rate from all causes had increased only in the same proportion as in these other towns, the actual number of deaths would have been 1,000 less.

The action of solar radiation is discussed, as are also the effects when sunlight is obstructed—loss of visibility, psychological smoke gloom, and increased incidence of rickets and cachectic states. The Meuse Valley disaster is also discussed briefly. (USPHS)

1936

1105. ROHOLM, KAJ. [On the Cause of the Fog Catas
trophe in the Valley of the Meuse, December 1930.] Hospitalstindende, vol. 70, 1936; abs. (Air Pollution, an Annotated Bibliography), Univ. of Southern California, Sch. of Med., Los Angeles, 1939.

This catastrophe was accompanied by several thousand illnesses and 60 deaths. The probable cause of
illness and death was the concentration of toxic fluo-
ride compounds produced by 15 of the 27 factories
located in the valley and blanketed near the ground
by the peculiar atmospheric conditions that existed at the
time. A map of the Meuse Valley area involved, show-
ing the towns, industrial plants, and location of the
deaths, is included.

1937


The mysterious fog catastrophe caused several thou-
sand cases of disease and 60 deaths. Acute and chronic
fluoride intoxications are reviewed; this catastrophe
probably was acute fluoride intoxication. Fifteen of the
27 local factories used raw materials containing
fluoride, and possibly gaseous fluoride was given off
in the smoke from the chimneys. Special climatic and
topographic conditions played an important part in the
catastrophe. (USPHS)

1938


Pittsburgh presents an unusual opportunity for the study of the relationship of smoke to pneumonia for two reasons: The annual death rate from pneumonia is higher than that for the State of Pennsylvania, and the atmosphere is laden with dust and smoke, partic-
ularly during the autumn and winter months when the rate is highest. The evidence accumulated is re-
viewed, and the results acquired by analyzing the findings in the lungs of 3,000 persons dying from vari-
ous diseases in Pittsburgh hospitals are given. It should be emphasized that the series of cases does not comprise an industrial group but represents a cross section of the general population.

The reports and microscopic sections of the 3,000 necropsies were reviewed, and the cases were separated into pigment-free lungs and five grades of anthracosis, depending on the amount of extraneous pigment and the fibrosis present. The incidence of all forms of pneumonia and of lobar pneumonia was tabulated in relation to each grade of anthracosis. In spite of the high local pneumonia death rate, no anatomical evi-
dence of a relationship between the incidence of pneu-
monia and the milder grades of anthracosis could be demonstrated; but in the three higher grades the per-
centage of pneumonia cases was definitely higher. The average age, however, in the higher grades coincided with the period of life at which the pneumonia death rate in less smoky communities is likewise highest. Healing by organization of unresolved pneumonia was consistently higher in all the more advanced grades of anthracosis.

Nothing tangible was found to connect the pigment deposits with the high pneumonia incidence and high mortality rates, but the association of severe anthracosis and healing by organization formerly reported was verified. (BH)

1939

1108. ELSLÅG, D. [Factory Smoke Containing Mannag-
nese a Contributory Cause of Epidemics of Pneu-
monia in an Industrial Community.] Norsk. Med.,
vol. 3, 1939, p. 2527.

Morbidity and mortality studies were made on the incidence of pneumonia in a community in which a manganese extraction plant was located. The lobar pneumonia rate, both for morbidity and mortality, was found to be high. This is believed to be due to effluvia from manganese plant and probably a manga-

nese compound itself. (USPHS)


Before the electric smelting of ore was introduced to this town, Sauda was one of the healthiest in Nor-
way. Now the mortality from croupous pneumonia among persons between 15 and 29 years is calculated as being 22 per 10,000, whereas it is only 1 for Oslo and for the country as a whole. Several attempts to solve the problem have been made; the latest points to man-
ganes as the offender. (JHFT)

1940


A report on air contaminants, listing the various types, is presented for the year 1939. Graphs indicate monthly levels of suspended impurities. Other mea-

surements include sulfur dioxide and sunlight. Pollu-
tion by suspended matter is compared with the deaths from respiratory diseases.

It is a well-established fact that the death rate from respiratory diseases is higher in cities than in rural areas, and in larger cities such as Manchester periods of fog are followed by a rise in the death rates from such diseases. City fogs are due to an increase in the amount of suspended matter in the air.

A graph comparing the intensity of fog pollution each week with the weekly total of deaths from respiratory diseases in Dublin shows markedly similar curves. It is concluded that any pronounced rise in pollution dur-
ing the winter is followed shortly by a rise in the death rate.

High pollution by suspended impurity is accompanied by corresponding high pollution by sulfur dioxide, and periods of high pollution by these impurities are always periods of low temperature.

Death rates of Dublin County and the city are com-
pared, showing a marked increase in the city, due allegedly to air pollution. (USPHS)

1941


Long before 1800 Pittsburgh was known as the "smoky city." Visitors like Anthony Trollope were able to appreciate the unrivaled grandeur of Pittsburgh's situation, but the citizens who had to live there were not so easily consoled by the view.

The medical profession believes that smoke is a health menace of major proportions. However, there
are few scientific facts distinctly to establish a case of cause and effect. The effect of smoke on health in any individual cannot be actually determined.

Results of a study of cities selected by the United States Public Health Service during 1931 to 1933 and
divided into three groups according to the degree of their atmospheric pollution are given. Charts compiled from the data obtained in the study show that the greater the contamination of the air the greater the number of pneumonia deaths, but no such correlation between tuberculosis mortality and the general death rate could be determined. In fact, the figures strongly suggest that death from tuberculosis is inversely pro-
portionate to the pollution of the atmosphere. A sharp increase in the pneumonia mortality rate can be pre-
dicted accurately after a heavy smog lasting more than 2 days. The complex tars, gases, and solids, other than carbon, are the important elements contributing to the pathogenesis of respiratory disease. Smoke contributes immensely to the deficiency in ultraviolet light, a most essential agent in maintaining resistance to infection.

Measurements of substances, both solid and gaseous, found in Dublin's air were made and the results tabulated. Several graphs are included, one of which shows relationship of pollution to deaths from respiratory disease. (USPHS)

1942


Soluble solids deposited during 1941 at Leinster Lawn amounted to approximately 74 tons per square mile and were about 1.6 times the amount at Glasnevin. Insoluble solids at Leinster Lawn were deposited at the rate of 126 tons per square mile and were 3.4 times the amount at Glasnevin. Aside from insoluble matter at Glasnevin, which is 37 percent higher than that recorded in 1940, the deposits do not differ greatly from those recorded in 1940. Owing to the shortage of coal, total pollution due to suspended impurity was only one-half the average for the preceding 3 years. The maximum number of deaths from respiratory diseases during the winter is the lowest recorded in the years during which the investigation has been carried out, a fact which is probably due to the decline in the contributory factor of suspended impurity. At Leinster Lawn the total pollution by SO, was 0.6 of the average of the preceding 3 years and at Albert Farm, 0.6 of the average of the preceding 2 years. A graphical method is presented for comparing pollution by suspended matter with directions and velocities of wind. For the period 1938–40, when coal consumption was normal, the data show that the north-northwest, northwest, and west-northwest winds are the most heavily polluted. The St. Louis smoke-abatement ordinance is cited for its interest in the prevention of smoke pollution. (JIIHT)

1943


Average monthly figures for 1942, in grams per square decimeter, include rainfall (in millimeters), pH of rainfall, insoluble matter, soluble matter, sulfate, chloride and nitric and nitric oxide. The maximum of the insoluble matter and total solids. Average yearly observations obtained with deposit gages from 1938 to 1942 are tabulated, showing rainfall, soluble and insoluble matter, and total solids. Both soluble and insoluble deposits declined slightly during 1942, but total solids showed a decided upward trend at both Leinster Lawn and Glasnevin from 1938 to 1942. Curves give the CI and SO, averages in rainwater during the same period, both years showing a minimum in summer and a maximum in winter. Graphs comparing pollution with temperature and deaths from respiratory diseases are presented. Periods of minimum temperature were periods of maximum pollution, and such periods are followed by a maximum number of deaths from respiratory diseases in Dublin. The winters following 1940 were years of coal shortage and consequent diminishing pollution. Deaths in January 1942 and 1943 were the lowest in the entire period studied but were considerably above the summer and a maximum in winter. The authors indicate that if records were kept over a long enough period it might be possible to differentiate between increased deaths in winter due to pollution and those due to other causes. Measurement of sunlight was recorded for two periods, but no definite conclusions were drawn. (JIIHT)

1945


Reflecting the influence of fog, London death rates from respiratory diseases in 1934 rose from 49 to 121 the week before the fog to 121 in the last week of the foggy period. Animals also suffered and “suffocated.” The fog and smoke have a marked deleterious effect on grass and vegetation. (USPHS)

1946


In both Cincinnati and Pittsburgh the incidence of pneumonia is much higher in districts with high sootfall rates than in other districts of the cities. Both sootfall and pneumonia rates are much higher in Pittsburgh than in Cincinnati. That other factors besides the socioeconomic are responsible is evidenced by the fact that in the low-lying smoky areas the pneumonia death rates for males is 35 percent higher than for females, while in the hilltop suburbs the pneumonia death rate for males is 3 percent higher than for females. The author rules out other possibilities for this difference, such as altitude and differences between males and females to resist exposure. Correlations for tuberculosis and respiratory-tract cancer are similar but less marked. Despite a search for other causes would be found for sinusitis, bronchitis, and other minor respiratory diseases if reliable statistics were available.

Exhaust steam from power sources adds greatly to the winter smoke problem by remaining as a fog to hold the flue products suspended in the air. Remedial steps should include: (1) Use of low volatile coal or proper equipment to burn high-volatile grades smokelessly; (2) effective trapping of fly ash in chimney or stack; (3) preliminary washing of high-sulfur coals; and (4) use by the railroads of diesel or electric power within metropolitan limits. (JIIHT)


The clinical picture and pathogenesis of CO poisoning and the poisoning in drivers of motor cars operated by charcoal gas in Finland are described. In the 5,000 drivers who were questioned symptoms of CO poisoning were found in 67.5 percent of the cases; 3,060 showed symptoms of acute poisoning, and 2,506 showed symptoms of chronic poisoning. In 500 cases the poisoning had caused permanent nervous damage. CO poisoning is the most common occupational disease in Finland at present. (FA)

1946


The health hazards of air pollution are compared with morbidity and mortality figures, and smoke-abatement measures are considered. It is believed that a large portion of the solids contained in city air could be eliminated by proper operating practice. Some common errors made by engineers and firemen are: (1) Cleaning fly-ash accumulation at base of stack by stirring up ash so that it is discharged out of stack; (2) cleaning breeching and settling chambers in boilers at irregular and infrequent periods; (3) burning rubbish in base of stack or on grate of unused boiler with damper wide open; and (4) using cleanout door in breeching or at base of stack as means of ventilating a boiler room. (APB)


The National Smoke Abatement Society conference held at Brighton in 1946 dealt largely with smoke-abatement progress and plans for further achievement.
The people of Manchester are reported to have seen the hills for the first time when the general strike of 1911, and 300,000 deaths from pneumonia and tuberculosis in the United States were reported by the surgeon general of the nation. The annual rate of 13.2 per 1,000. Leeds experienced the same due to a snowstorm.

EFFECTS OF AIR POLLUTION

The relationship between atmospheric pollution, as determined by sootfall, and respiratory-disease death rates in the various districts of Cincinnati and Pittsburgh is highly significant. Also, the incidence is much higher among males (2 or 3 times), whereas the difference between male and female in suburban areas is slight. Respiratory diseases, including influenza infections, account for about 70 percent of working time lost by employed persons on account of illness. The smoke problem should be considered on a health basis alone, without regard to the other savings which would accrue with elimination of smoke. (USPHS)


Statistics are presented to show that the mortality due to pneumonia and tuberculosis is in direct ratio to the amount of atmospheric pollution. For Cincinnati and Pittsburgh the incidence was highest in the home-laying parts of the city, where sootfall was also greatest. A close relationship also exists between pneumonia rates and such socioeconomic indices as rental values, overcrowding, and income. A comparison of male and female rates, however, does not indicate this relationship. A comparable rate would be expected for the same families. Actually, however, the incidence among males in polluted areas is twice that of females, whereas in higher suburban districts, regardless of income group, the ratio is about 1:1. It is concluded that the difference lies in the fact that at work the men are exposed to greater pollution. (USPHS)


Anxious to minimize atmospheric pollution in the interests of health, fuel economy, and improvement of the district, Willenhall Council recently called a conference, which was attended by members of the council and manufacturers. The conference was told that in urban areas where smoke existed the infantile mortality rate was two-thirds higher than in rural areas and that the death rate in the respiratory diseases was almost double. The benefit to industrialists through cooperation in dealing with the problem was emphasized, because it was estimated that when black smoke was emitted there was 10 percent waste of fuel. (APB)


There is evidence that during the past quarter of a century the production of smoke has been reduced, and its ill effects on health have diminished. The deleterious effects of smoke are worse when fog and frost are combined with smoke. The mortality from pneumonia and bronchitis is increased during a smog and for weeks thereafter.

One of the worst examples was a fog of 75 hours' duration, accompanied by frost and influenza, in Glasgow in January 1929, when the death rate rose to the high figure of 50.5 per 1,000 population in the third week of the month as compared with 15.3 per 1,000 for the whole year. In 1989 Manchester had 13 days of fog during February, the death rate rising to 34.4 per 1,000 by the end of the month, as compared with
ill and 20 died during a smog. It details some "human interest" stories and gives some of the highlights of the report of the U. S. Public Health Service, which made a detailed scientific study of the episode. (USPHS)


The dense fog that enveloped London and much of the country during the closing days of November 1948 established a record, not for density but for duration. Commencing in London on the night of Friday, November 28, it persisted until Wednesday, December 1. The total weekly deaths from all causes registered in Lon-
don during 44 to 51 weeks of the year 1944 through 1948 and those from nine selected causes are tabu-
dated. Deaths from bronchitis and from pneumonia are given by age groups, as are also those for each of the 44 to 51 weeks in 1948.

The sharp rise in deaths registered during the week of fog stands out clearly—an increase of 20 to 30 per-
cent over the deaths recorded in any one of the preced-
ing 4 weeks. The effect of the fog continued into the 49th and perhaps the 50th week of 1948.

The increased mortality was due largely to respira-
tory infection. Registered deaths due to bronchitis and pneumonia more than doubled during the 49th week, with some increase from myocardial degeneration and cancer. Mortality from other causes was little, if any, higher than in the preceding 4 weeks.

No increased mortality from bronchitis or pneumonia is revealed under the age of 45. The increase was nu-
merically greater above the age of 65 but proportion-
ately greater in the 45 to 65 age group. In the next 2 weeks (49 and 50) the bronchitis death rate returned to normal, but deaths due to pneumonia in the elderly remained high.

Infant mortality due to pneumonia did not increase during the week of fog but rose the following week. (USPHS)

1127. LONDON TIMES, Deaths During Fog. Big Increase Among Elderly, 1949.

The dense fog that occurred at the end of November last year was unusual both for its duration and its intensity. It also caused a considerable increase in mortality returns, some details of which are given by an official of the General Register Office in the current issue of the Lancet. There was a sharp rise in the number of deaths registered during the week of the fog, an increase of 20 to 30 percent compared with the number for each of the 4 previous weeks. As might be expected, the deaths were due to respiratory infec-
tions, especially bronchitis and pneumonia, among the elderly rather than the young. The death rate from bronchitis quickly returned to the average level, but the deaths from pneumonia among the elderly and among infants were high in the week after the fog. (APR)


In the latter part of October 1948 Donora, Pa., a town of about 15,000 population, containing a zinc plant and a steel and wire plant, experienced a large number of acute illnesses and 20 deaths during a heavy smog. This report is based on a carefully made epidemiologi-
ical study, approached from the biologic, the engineer-
ing, and meteorological points of view.

The data were collected after the episode was over and included: (1) Study of acute morbidity by house-
to-house canvass, records of fatal and hospitalized patients, and study of general morbidity; (2) study of chronic morbidity by dental examinations of school children; and by certain chest roentgenograms, and morbidity of selected groups of individuals; (3) study of mortality records of the community and comparison of these with similar records of neighboring towns; (4) atmospheric studies of air pollutants; (5) evaluation of industrial-plant effluents; (6) evaluation of air contaminants from other sources; (7) description of the topography of the valley in which the town is located; (8) micrometeorological studies of the valley; (9) description of the weather during the acute episode in October 1948.

Detailed description of the methods used are pre-

presented since it was believed they would be useful to others making similar studies.

The study showed that the cause of the episode was an accumulation in the atmosphere of chemical irrit-

ants; this accumulation resulted from the weather inversion which existed in this part of the country during the fateful days. The role of all sources of chemical contaminants in air are discussed. A section is devoted to the specific agent or agents probably responsible for the illnesses, but no one agent could be named. The sickness likely was due to a chemical irritant (possibly sulfur dioxide) plus particle matter, although, because of the lack of knowledge about the toxic effects of low concentrations of the irritant gases, this cannot be said with certainty. (USPHS)


The epidemiology of an acute episode of October 1948 is discussed. It indicates that in addition to 20 deaths, the illness of 43 percent of the population was caused by smog over Donora and the nearby com-

munity of Webster for 5 days. (APR)

1950


Reliable measures of morbidity are necessary before an attempt is made to attribute ill health to a specific cause such as air pollution. Very little current information is available concerning morbidity in different types of communities. One of the first things to ascer-
tain is whether consistent differences in morbidity either in total or for specific diseases can be found among persons exposed to air pollution as contrasted with persons not so exposed. If such differences exist, their possible relationship to air pollution may be deter-
ned by detailed clinical studies or by experimental investigations.


A poisonous refinery smog which spread over the suburb of Poza Rica, an eastern Mexico oil town, took the lives of 15 persons November 24, according to the Associated Press; 49 of the 60 persons affected were hospita-

lized, and 3 were in serious condition the follow-

ing day. It is believed that the smoke from a refinery plant mixed with a heavy fog was blown down on the settlement. Poza Rica is surrounded by oil and gas wells in the low hills, and the afflicted settlement, which bears no name of its own, is among the hills.


Earlier work on atmospheric pollution in Dublin dur-

ing 1938 to 1941 appeared to show a relationship be-
 tween pollution due to suspended matter and deaths due to respiratory diseases. In 1942 and 1943, however, when the chief fuel was peat pollution due to suspended matter and to sulfur dioxide fell to very low levels,
but the deaths did not show a corresponding reduction. Peak values for pollution were low during the winter months of 1942 to 1947 but rose in 1948 and 1949 as coal became more plentiful. The peaks in the death rates from 1942 to 1949 appear to have no relationship to pollution at the corresponding periods. It was concluded that these results indicate no direct relationship between atmospheric pollution and deaths from respiratory diseases in Dublin.

1951

In the spring of 1950 the Maryland State Department of Health requested the Public Health Service to join with it in considering how it might use a limited sum of money to reduce the health hazards associated with industrial facilities. The conclusion was that there would be a benefit to health from measures taken to reduce air pollution. The department of health has been charged by the State legislature, through the Governor’s commission on noxious fumes, to make such studies. The report of a preliminary study about 1950 should be completed in the near future.

Considering the circumstances of time, facilities, and money ($5,000), it was agreed that the avenue of effort with the best possibility of fruitful results was a study of morbidity. As factual data on morbidity in its relation to continued air pollution were sorely lacking, it was felt, too, that the information obtained through such a study would add materially to the present sum of knowledge.

A method of studying air pollution in relation to human morbidity is presented. In the present instance, the degree of air pollution was indicated by dustfall measurements.

Within the limits of this survey the data show that the frequency of the common cold was significantly greater in the high-dustfall area than in the low-dustfall area and that this difference was not due to differences in socioeconomic status, age, sex, or occupation.

The method presented, as indicated by the collected data and their analysis, suggests a need to study the perplexing problem of the effects of air pollution on health.

1952

Studies in Los Angeles show that death rates for cardiac and respiratory diseases are higher during periods of two or more smoggy days in succession than during similar periods of clear weather. The implication is that smog irritants increase respiratory and cardiac difficulties for those already suffering from these diseases that the more acutely sick die. Whether years of exposure to minor smog irritations may lead to respiratory and cardiac diseases remains an open question. (APB)

OBSTRUCTION OF LIGHT BY SMOKE

1909

On an average working day 20 tons of soot is emitted into the air at Leeds. A record is given of the atmospheric impurities carried down by rain; the effect of this rainwater on vegetation and the diminution of daylight caused by suspended particles of soot are discussed.

An investigation carried out during the month of June revealed that the amount of daylight in the center of the city was only half that several miles from the city.

1914
1136. HINSDALE, G. Atmospheric Air in Relation to Tuberculosis. Smithsonian Inst., 1914.

It is believed that the “climate may be used as an adjunct of great value for carrying out the hygiene, dietetic treatment of all forms of tuberculosis and of many other diseases.” Therefore, the incidence of tuberculosis can be reduced by keeping the air clean. The benefits of clean air and sunshine are discussed. (USPHS)

1923

This treatise on the problem of smoke abatement emphasizes the part that domestic chimneys play in the production of smoke. Domestic smoke is considered a far worse offender and is more difficult to handle. The filth caused by smoke is stressed. The resultant loss of sunshine through a cloudy atmosphere is said to be detrimental to health because of the loss of its bactericidal effect, its stimulating effect, and its health-giving capacities. (USPHS)

1924

Fresh air and sunshine along with splints are beneficial in curing children of rickets and tuberculosis of the spine or joints. The ultraviolet rays are the most beneficial; they are discussed and classified. Clothes, glass, mist, and smoke cut off the ultraviolet rays. Lack of them, through smoke obstruction, is detrimental to vegetable life. The death rate increases when a combination of smoke, fog, and white frost occurs. (USPHS)

1926

Smoke abatement, as carried out in a number of cities, has been of material benefit to the manufacturer by giving better combustion and lower fuel cost and to the public by reducing smoke, increasing sunshine, and reducing laundry bills. Antismoke laws have eliminated only part of the air-pollution evil. Also included are descriptions of an antismoke ordinance and its provisions, smoke surveys, and corrective measures to minimize dense smoke.

Smoke and other items of air pollution fill the atmosphere with acid, poisonous compounds and soot particles, which irritate the sensitive membranes of the eyes, nose, throat, lungs, and gastrointestinal tract; increase the susceptibility of gastrointestinal, pulmonary, and nasopharyngeal disorders; diminish the potential reserve, working capacity, and well-being of the individual; increase fatigue, irritability, and malaise; and may tend to hasten premature decay. Smoke content of the air has some effect on the pneumonitis death rate but little on the tuberculosis death rates.

Smoke reduces the intensity of daylight by shutting out much of the blue and ultraviolet rays of sunshine, which normally exert a bactericidal effect on the pathogenic bacteria and a tonic and vitalizing effect upon man. (USPHS)

1927

The City of Manchester is divided into a central and an outlying section, with equal populations for the purpose of comparing mortality rates of various diseases. In 1926 only 55 percent of the light received in an area 6 miles south of the city was found in
Manchester proper. This reduction is attributed to atmospheric pollution. (USPHS)

1928


Smoke eliminates ultraviolet rays, which are necessary for health. Several statements, unsupported by figures, regarding the deleterious effect of smoke on health are given. (USPHS)

1929


Observations were made to determine to what extent the ultraviolet radiation of the sun is obstructed by atmospheric pollution. The observations were made by a variety of chemical methods, most reliance being placed on the lithophone test of Clark. It was found that the ultraviolet radiation some 10 miles outside Baltimore was 50 percent greater than in that city. Many times were observed of the absence of solid matter in suspension in the atmosphere of these and other situations: In the country there was only about a sixth of that in the city. Carbon as tar-like product was found more obstructive to ultraviolet light than siliceous material in dust. (BH)

1930


Certain therapeutic and physical aspects of heliotherapy were studied by the Harvard School of Public Health in cooperation with the Harvard Medical School and the Children’s Hospital, Boston. Continuous records were obtained, over a period of 16 months, of visible daylight and atmospheric dust on the roof of the Harvard School of Public Health and intermittent records of solar ultraviolet light inside and outside the neighboring Children’s Hospital and at five other stations in Massachusetts.

Records of daylight were correlated with dust counts, wind velocity, and percentage relative humidity. Results indicated slight inverse relationship between dust counts and daylight (coefficient = –0.1801) and dust counts and wind velocity (coefficient = –0.1501). At the recording station on the southern edge of the city 68 percent of the maximum daylight possible was received. Although conclusive proofs are lacking, it seems probable that natural causes more than smoke pollution account for this transmission figure. Measurements of solar ultraviolet light by the acetone-methylene blue method are plotted for six stations in Massachusetts. The degree of atmospheric pollution in the vicinity of the Boston recording station is not sufficient to destroy the therapeutic value of sunshine, even during the winter months.


Air pollution cuts off the shortest ultraviolet rays first, thus reducing actinic intensity, which is greatest in the short ultraviolet rays. Erythema range is principally 3,020–2,970 A., which coincides with the anti-radiation range.

In the study cloudless days were used for uniformity, with test stations dispersed about the city of Chicago and control stations outside and windward to the city. Most severe obscuring effects were observed in late fall and early spring. In summer, when combustion of fuel for heating is at a minimum, the loss of ultraviolet light is still considerable. Studies were made over a 3-year period. (USPHS)


The relative loss of light in various parts of New York City is considered. The results showed that loss of light depends, among other things, upon altitude of the sun, nature of daylight (clear or cloudy sky), relative humidity, and velocity of the wind. There was a large relative loss of light at the Hudson Street Marine Hospital due to smoke. (USPHS)

1931


The Report of the Standing Conference of Cooperative Bodies gives the results of an inquiry as to the methods adopted by various authorities for the reduction of pollution. Some of these methods are: (1) The installation of dust-collecting devices at local power stations and use of smokeless methods of heating in public institutions; (2) the maintenance of observations of pollution and sunlight and publication of results monthly in local newspapers; (3) the provision of demonstrations and exhibitions of modern heating appliances; (4) the formation of a smoke advisory committee, including practical engineers; (5) the organization of a course of instruction in connection with boiler efficiency and smoke abatement.

The Atmospheric Pollution Research Committee has initiated an investigation of the distribution of pollution under different conditions of wind and temperature. The research referred to in the fifteen report were continued throughout the year.

The report on observations with the deposit gauge shows that, on the whole, the purity of the air was improved. Measurements of daylight in Leeds by the potassium iodide method show that over a period of 9 months there was a reduction of 15 percent in average value (expressed in milligrams of iodine) in the center of the city as compared with the outskirts. Observations of ultraviolet radiation in Sheffield and Rotherham show that the reduction in ultraviolet radiation is roughly related to the quantity of impurity deposited.

A short paper by J. R. Ashworth, Observations on Ultraviolet Light in Rochdale and Some Other Places, forms an interesting appendix to the report. The observations were made by the acetone-methylene blue method. Of the amount of ultraviolet radiation received on the outskirts of the town (Rochdale), 29 percent is intercepted at the center of the town. In the center of the town the light received on weekdays is about 71 percent of the light on Sundays, while a mile away it is 91 percent. Observations made in Manchester and at a station 10 miles away in open country show a loss of light in the city of as much as 45 percent. The power of the ultraviolet rays measured by their fading action per hour is not uniform but depends on the season in such a way that the power is proportional to the sine of the altitude of the sun. For this same reason when comparing the ultraviolet data for different localities a correction of latitude should be introduced. (BH)


Medical reports show that more than half of the children in England who have attained the age of 3 years are afflicted with rickets, a life-crippling disease of darkness. Weather conditions in the English cities combine with the smoke nuisance, fogs, and other barriers to block off sunshine with its healthful ultraviolet
rays which build bone, quiet the nerves, increase the red corpuscles in the blood, and facilitate calcium and phosphorus deposition in activating man with the sunshine vitamin, notably, vitamin D.

London, for example, burns more than 3,000,000 tons of coal daily for both domestic and industrial purposes. Because of inefficient use of this coal supply, only about half of it produces heat, while the balance pollutes the atmosphere with smoke, soot, and other byproducts of fuel consumption. Experiments conducted by the British Sunlight League have disclosed that as much as 20 to 30 tons of foreign matter is blown in 1 square mile of air area above London in the course of 12 months. Conditions are so bad that large amounts of coal dust and even particles of coal are found frequently in the lungs of those who die from respiratory diseases and similar ailments.

Children raised in this smoky atmosphere, where the sun is veiled for days at a time by smoke, soot, and fog, are naturally sickly. The British Sunlight League, organized in 1926, seeks to curb such sacrifice of human life and limbs to fog and soot. Its organization, as well as the British Sunlight League, has shown that the air is a factor in the disease by hemothropic and heliohygiene treatment.

This campaign has also been successful in obtaining the official consent of the authorities for the use of certain areas in the public parks for sun-treatment purposes.


Loss of light was greater on cloudy days than on sunny; for the same kind of sky, clear or cloudy, the average percentage loss of light increased with increase of relative humidity. During clear weather the average percentage loss was twice as great for a relative humidity of 65 percent as for 35 percent. For a cloudy sky the increase with relative humidity was not as great. The percentage of light lost decreased as wind velocity increased. (USPHS)

1149. TOWNES, F. O., and DEVONG, C. R. Smoke Eradi-

Studies made in several American cities show a decided loss of the short rays and actinic intensity of the sun most of the year.

Two charts are presented: one shows the "relation of total deaths to erythema hours of sunshine per month in Chicago, 1926-27," and the other the "relation of deaths from acute respiratory disease to erythema hours of sunshine per month in Chicago, 1926-27.

The striking feature of these charts is the remarkable correlation between respiratory disease deaths and erythema hours per month; low erythema hours are followed by high respiratory death rates with a lag of 1 to 2 months. Conversely, the higher erythema hours per month are followed by correspondingly lower respiratory death rates, after a similar lag. (USPHS) 1933

1150. Ives, J. E. Loss of Light Due to Smoke in Balti-

The readings of two similar photoelectric cells were compared, one of which was on the roof of a building in a central position in the city of Baltimore and the other at a sanatorium situated on an eminence some 570 feet above sea level and 10½ miles from Baltimore. The report deals with the observations from October 1929 to September 1930. The difference between the records obtained with the two recorders attached to the photoelectric cells was taken to indicate the loss of light due to smoke in the atmosphere.

The apparatus employed is the same as was used in a similar study in New York City, described in Public Health Bulletin 195. The cells had cathodes of aluminum coated with barium.

No records were taken on rainy days; the observable days were classified as "clear," "cloudy," and "mixed." The total loss of light was found to be greatest in July and least in December—those 2 months when the total illumination was, respectively, greatest and least. (The result, perhaps remarkable in that during the month of December much more fuel is consumed for heating, agrees with the New York study mentioned.) An unexpected finding was that on certain days greater intensities were recorded on the city roof than on the hill; the author suggests that this may be caused by the scattering effects of a thin layer of haze. The relationships between relative humidity and percentage light loss and the variations of percentage light loss for clear and cloudy hours do not agree with the New York findings. There are laws that relate intensity of light, direction and velocity of the wind are recorded. (BH)


An effort is made to stimulate interest in smoke abatement. General effects of smoke, such as loss of sunshine and clean air, important health factors, are mentioned. (USPHS) 1934


The primary purpose of the paper is to give some data obtained from 12 months' continuous records of ultraviolet radiation. The effect of health of loss of radiation due to smoke is not discussed. (USPHS)

1153. BRITISH DEPARTMENT OF SCIENTIFIC AND IN

Examination of the instrument developed at the National Physical Laboratory has been carried a step further. This photometric apparatus, which measures light from a limited portion of the sky, has been compared with a photoelectric instrument, which gathers light from all directions. The comparisons have been satisfactory. (BH)


The Public Analyst of Salford contributes an account of observations of ultraviolet (duration x intensity), as measured by the discoloration of self-tokening photographic paper exposed to the sky through a piece of "ultraviolet glass" and an optical "wedge" composed of successive layers of tissue paper. It was found that ultraviolet radiation and hours of sunshine, as recorded on a Campbell-Stokes recorder, followed the same trend. These results also indicate that the proportion of ultraviolet to visible light is much less in winter than in summer.

Ultraviolet (duration x intensity), measured by the bleaching of acetone-methylene blue, for the first time are recorded in these reports for Kingston-upon-Hull, Rotherham, Sheffield, and Stirling. The deposits of total solids are tabulated with these ultraviolet readings, and no relation can be traced. (It may be noted that a long series of comparisons between ultraviolet light, as measured by this method, and visible light (chiefly blue), as measured by the Eder photometer, in 1925 showed a large and rather unexpected disparity. (Hill, Leonard, Rapport, Conference internationale de
AIR POLLUTION—A BIBLIOGRAPHY


This study of atmospheric pollution by smoke in Lancashire reveals that insoluble material was more highly concentrated in the center of town, whereas soluble material was more widely distributed. Atmospheric pollution caused a marked reduction of sunlight and, in particular, of ultraviolet radiation. (USPHS) 1935


The measurement of loss in antirachitic potency of the radiations from a quartz arc lamp, after passage through an atmosphere of smoke, and an attempt to correlate the results with external conditions are considered from the technical viewpoint. Albino rats were used, and the criterion was comparison by bony calcification. Determinations were made of bone ash, blood phosphorus, and X-ray changes in bone. Comparison of results was significant in proving that the smoke reduced the radiation, with loss of antirachitic properties. Review of literature is cited. (USPHS) 1937


Statistics show a close relationship between death rates and atmospheric conditions. The number of deaths from pulmonary and cardiac diseases increased in direct proportion to an increase in the intensity and duration of smoke fogs. Tarry matter of smoke is suspected of producing cancer in the lungs. Manchester received only 55 percent of the daylight received by a neighboring town on a still day and only 5 percent on a foggy day. Therefore, calcium and phosphorus could not be assimilated through the action of ultraviolet rays. Rickets and anemia developed. Smoke sloss lessened the potential reserve, working power, and well-being of the individual. Garden produce and pastureland have been so reduced by smoke that the lettuce supply was only 51 percent of the natural yield. (USPHS) 1938


The pleasantness of outdoor atmospheric conditions, as evidenced by the opinion of a group of some 80 persons, taken for 1 hour a day for a week, is influenced, first, by sunshine and then by relative humidity and total ions. The total ions in the air are largely made up of the gaseous products of combustion. (USPHS) 1938


To demonstrate more fully the need for the elimination of smoke and air-borne dirt, the general physics of the sun’s radiations as they reach the earth and their effects upon man are reviewed. Ozone, clouds, and haze by absorption modify the radiations that reach the earth. The remaining radiations of physiological importance are greatly modified by the smoke pall from cities and, again, by the physical nature of the surfaces on which they fall. Thus, white plaster has a high reflective power for all rays of the sun. Sand has a high reflective power for infrared rays, while snow and green fields have a small reflective power for these rays. Sunlight has a wonderful curative effect on wounds and is valuable for certain skin diseases. Incipient boils and carbuncles may be checked by strong doses of artificial sunlight. Sunlight and open-air treatment are of great value in the treatment of tuberculosis, but great care must be exercised in applying ultraviolet radiations in the treatment of tuberculosis of the lungs.

Recent research has shown that the air tubes of the lungs are narrowed reflexively by way of the nerves when the skin is irradiated with dull-red or dark heat radiations; this effect is counteracted by cooling the skin with a fan and in many instances by rays from a bright source of heat.

Good water and good drainage have been obtained; attention now should be directed toward obtaining clean air. (BH) 1937


The loss of ultraviolet light increases morbidity due to tuberculosis, rheumatic fever, rickets, and respiratory infections and lowers the tone and vitality of the populace. In this study all fuel going into New York City for 1934 was analyzed as to type, amount, and distribution, and the types of fuel-burning equipment were summarized. Sootfall measurements were made at locations throughout the city during the year. Measurements of concentrations of streptococci and pollen were also made at various points. The study was made in part to bring up to date the sanitary regulations regarding smoke and air pollution in New York City and to form a basis for long-range planning. (USPHS) 1938


A controlled experiment conducted as part of the Toronto investigation showed that smoke in concentrations normally occurring in urban atmospheres diminished the ultraviolet energy to an extent where it ceased to prevent rickets in rats. Four tables, representing four collection areas for smoke particles and listing soluble and insoluble matter, total solids, and sulfur dioxide in tons per square kilometer, are given. The atmospheric pollution of Toronto is compared graphically with that of London and several United States cities. (USPHS) 1942


Admittedly, the harmful effects on health ascribed to smoke and air pollution are based on very few observations. There are few scientific facts to establish cause and effect definitely. For example, whereas a rural adult demonstrates small hiliar shadows, the urban adult demonstrates increased hiliar shadows. Though both are considered “normal,” the prognosis in case of tuberculosis is better for the urban dweller. Apparently, the shadows are the result of fibrosis and lymph blockage.

The correlation between air pollution and pneumonia deaths is discussed at length and includes tables covering several large cities. It has been established definitely that prediction of an outbreak in incidence of pneumonia deaths can be made for a smog lasting 2 days or more.

The importance of sunshine to health is mentioned, as well as of the greater loss due to smog during the winter, when days are short, sun is low, and the weather is more cloudy. Air pollution thus intensifies the reduced duration of sunshine caused by natural conditions during the winter months. Resistance to cold and other illness is reduced, thereby creating a health menace. (USPHS)

Smoke deprives cities of their sunlight. In one large American city smoke deprived the community of 21.5 percent of its sunlight on an average day. It was also found that 25 percent of the ultraviolet rays were cut off passing through 200 feet of the city air. Smoke in suburban cities absorbs 55 percent of the antirachitic rays from the sun. A smoke-abatement program is discussed. (USPHS)

1947


Results of a study of air pollution in Chicago by the U. S. Public Health Service are summarized.

The U. S. Weather Bureau reported that in 1945 Chicago received only 50 percent of the possible hours of sunshine. Smoke alone was not responsible for this percentage but, combined with fog and cloudiness, was a factor in the sunshine record.

The various contributors to the smoke—railroads, steamships, buildings, and miscellaneous sources—are cited.


A previous communication (Jour. Ind. Hyg. and Toxicol., vol. 17, 1933, p. 199) showed that smoke, in concentrations normally occurring in urban atmospheres, diminished to a considerable extent the antirachitic effectiveness of the radiation from a quartz mercury-vapor arc lamp. In the present paper the amount of ultraviolet energy necessary to prevent rickets in rats is evaluated. Incidental to these measurements, the spectral transmissions of atmospheres of wood smoke have been determined to test the validity of the results of numerous direct determinations of absorption of solar ultraviolet energy by atmospheric smokes that have been obtained by photochemical and filter methods. (APB)

1951


The effects of living and working in a smoke-laden atmosphere may be divided into (1) direct ill effects of breathing polluted air and (2) ill effects caused by reduction of effective sunshine. The incidence and mortality from bronchitis and pneumonia during and just after foggy weather and the power of smoke to absorb light are discussed, and records made at Leeds and Glasgow are quoted. Figures taken from Glasgow City Analyst show the amount of daylight and ultraviolet radiation reaching the ground at Mearskirk Hospital 7 miles southwest of Glasgow and in the center of the city at Glasgow Cross. These figures show the great difference that exists between town and country stations in summer and winter. The importance of ultraviolet radiation, which effects a synthesis of vitamin D in the body, is discussed. (APB)


One factor—the mean annual hours of sunshine—is significantly correlated with death rates from lung cancer, bronchitis, and tuberculosis, for which the strength of the correlation appears to be much greater for lung cancer than for the other lung affections. Either smokiness of atmosphere is an important factor in itself in producing cancer of the lung, or sunshine is an important factor in preventing its incidence. (APB)

1953


Thermoelectric pyrheliometers were installed on the roof of the post-office building in Boston in January 1944 to measure the total solar and sky radiation received on a horizontal surface and to direct solar radiation on a surface normal to the solar rays. Similar measurements were made by the Harvard Blue Hill Observatory in cooperation with the U. S. Weather Bureau. A Smithsonian silver-disk pyrheliometer was employed as the check instrument for all the other pyrheliometers. The post-office building is in the business section of Boston, to which winds from all directions, except east, bring smoke-laden air. The observatory is 10 miles south-southwest of the post office, at a higher elevation, and is subject to very slight atmospheric pollution. Seasonal and diurnal variations of the ratios of total solar and sky radiation observed at the two locations were tabulated, and ratios between normal-incidence values at the two stations were found to be lowest in the early morning, with a secondary minimum in late afternoon. Planimeter readings for the winter periods revealed that radiation at Boston was 17 percent less than that at Blue Hill. In addition to the obvious disadvantages of a smoky atmosphere, health is affected through loss of ultraviolet radiation. (TID)


The method of measuring the attenuation coefficient, which is directly related to visibility, and the results of measuring the attenuation coefficient at different wavelengths, such measurements yielding an estimate of the size distribution of the aerosol, are discussed. The coefficients, as a function of wavelength, describe the effect of the suspended material on the light traversing it. This is based on the fact that when the air contains polluting substances, the size and size distribution of the suspended particles and their optical constants usually will differ from those particles that are present naturally. The results are said to agree with microscopic estimates. The results from the thermal precipitator are not inconsistent with measurements of attenuation coefficient. (9 refs. cited)


Fogs were produced artificially in a cloud chamber and transmission of light of various wavelengths measured. Low-pressure steam gave maximum transmission (0.4) at 4,700 A. and minimum (0.3) at 5,050 A. Fog from a water spray (intermittent, diameter of 0.02 mm.) showed maximum (0.4) transmission at 4,800 A. and minimum (0.28) at 5,200 A., followed by a steady increase to 0.6 at 9,500 A. Neither Rayleigh's nor King's scattering formula applied. (APB)

1952


Discussion on the very small portion of the spectral range of the sun particularly susceptible to air pollution and the possible effect it may have on human health.
when it is removed by air pollution. There is evidence that the ultraviolet rays from this portion of the sunlight is the principal causal agent of cancer of the skin of man. Sunlight produces vitamin D, which can be obtained by supplementing the diet, and, of course, sunlight burns. There seems to be no direct benefits from sunburn.

Whether sunlight has an important bactericidal effect on pathogenic organisms under conditions outside the laboratory remains to be established, and until that time very little can be said about it as regards air pollution.


An outline of light-scattering phenomena and of optical methods of size measurement and the theory of light scattering are presented, followed by sections on the theoretical values of extinction and total scattering; theoretical expressions for angular scattering; application to particle-size measurement and experimental evidence; and a comprehensive bibliography. (APB)

ON STRUCTURES AND MATERIALS

1864


Information on causes of the rapid decay (partly mechanical and partly chemical) to which some building stones are subject is still scanty.

Building stones may be divided into two classes: 1. Stones, like granite, porphyries, and most sandstones, that are not easily attacked by acids. 2. Stones, like limestones, dolomites, and some kinds of calcareous sandstones, that are composed of materials that are partly or entirely destroyed by acids with facility.

The destruction of the ornamental work of buildings, executed in Bath and Caen, or a similar calcareous building stone is caused by the formation of crystallized sulfate of lime on the surface. The crusts that may be seen in perfection on limestones covered with soot were found to consist principally of crystallized sulfate of lime, mixed with the constituents of ordinary house-coal soot and more or less undecomposed carbonate of lime.

It is pointed out that the active agent or black smoke is sulfate of ammonia, a salt that is in the presence of moisture transforms carbonate of lime into crystallized sulfate of lime.

The effect of a smoky atmosphere on vegetation also is discussed and sulfuric acid is given as the cause of this injury.

1906


Discusses the effect of the atmosphere of smoky cities on various kinds of building materials as well as upon the paintings and priceless art objects in the museums and private collections. Destruction is risked if something certain and practical is not done soon.

1910


Processes for prevention of stone corrosion (discovered by an Austrian named Kubelka) are described.

The first method employed is to thoroughly clean the surface so as to expose the pores. After the stone is thoroughly dry, it is saturated with a solution of potash or soda waterglass.

The second method of Kubelka’s is to saturate the stone first with a solution of sulfate of alumina in water, and when dry with a solution of potash waterglass.

Through these processes any soft limestone or sandstone made be made compact and hard. Its porosity and impermeableness will equal that of the hardest stone. After treatment it may be polished and cut.

1912


The architect’s problems in connection with the smoke nuisance are discussed.

Soot possesses the properties inherent in itself for making the worst kind of dirt.

1. Finely divided carbon forms the basis of the best black paints. It is opaque and has a large covering power (a little will make a large surface dirty).

2. It contains tar, which, as well as being black and corrosive, causes the soot to stick to any material with which it comes in contact.

3. Finely divided carbon has great absorbing power, absorbing large amounts of the sulfur acids, more especially sulfurous and sulfuric, with minor amounts of hydrogen sulfide.

The stone most easily affected is one that is easiest to work into desired shape for building purposes. Granite and similar stones, which are virtually unattacked by acid and are impervious to moisture, are extremely expensive because of the difficulty in working with them.

1913


This is a series of papers by several authors showing the effects of smoke on paint and on various building materials; the objective is to awaken the general public from its apathy regarding the evil of the smoke nuisance, the greatest blot on industrial centers.


Soot and associated substances given off by smoke and injurious to building materials. Soot is the product of the incomplete combustion of soft coal. It is not difficult to burn soft coal without the emission of black smoke.

Soot consists of (1) carbon, which has great covering power and absorbs the corrosive acids produced by sulfur-containing coal; (2) tar, which makes the soot cling tenaciously and contains carbonic acid and other injurious substances; (3) acids, such as sulfuric and sulfuric acid, sulfured hydrogen, and hydrochloric acid, which corrode and tarnish all the common metals; (4) ash, which is least harmful; (5) ammonia; and (6) arsenic. The latter two are found only in small quantities.

Metallic surfaces are damaged by soiling of the surface and by chemical action of the acids. Soot and the occluded acids soil and corrode stone, terra cotta, and brick and destroy their decorative value. Cleaning by sandblasting is objectionable and a temporary expedient, as the surface is soon as dirty as before. The logical step would be to protect the exposed surface by means of a harmless waterproof, permanent coating, which does not discolor the stone and gives an easily cleaned surface.

Results of tests on the effects of weathering on limestone due to the action of natural causes and smoke under different atmospheric conditions are presented. 1928


The effects on stone, metals, and vegetation are discussed. One adult breathes about 200 gallons of air in 24 hours, or about 34 pounds in weight, as contrasted with a daily intake of 5½ pounds of liquid and solid food. Unquestionably, the solids and gases in the air due to the burning of fuel irritate the eyes, nose, throat, and lungs, tending to aggravate or to cause inflammatory diseases of these organs and to increase susceptibility to certain specific diseases of the respiratory tract. (USPHS)

1930


Discusses tests made to obtain data for use in interpreting screen-corrosion experiments conducted simultaneously by the Bureau and the committee on screenwire cloth of the American Society for Testing Materials.

1934


The sulfurous content of smoke is responsible for much damage to stone buildings as well as to human respiratory passages, and since its deleterious action is greatly intensified by mixtures with adhesive tar and soot it should be limited. (USPHS)

1936


The weathering of the stonework in English towns is said to be due to pollution of the air by acid gases. The weathering of the stonework of the House of Parliament is mentioned. Although the action of lichens and micro-organisms is fully considered, such agencies are relatively unimportant compared with the action of the constituents of coal smoke. Pollution by solid products of combustion is also important, as soot carried by acid materials which it brings in close contact with the stone.


The new theory advanced regarding the effects of the products of combustion on buildings is that the presence of bacteria is the cause of corrosion and not the chemical action of the smoke. Thus, there are two conceptions of corrosion, one blaming the sulfur compounds liberated by the combustion of any sulfur-containing fuel and the other suggesting that smoke—whatever its effect on health—may assist in preventing the decay of buildings due to corrosion. It should not be difficult to determine which theory is demonstrably incorrect.

1939


Reviews published investigations dealing with deterioration of materials due to sulfur compounds in air. Materials tested were cement, stone, metals, paint, leather, paper, and cloth. In laboratory tests sulfur content and humidity of air were controlled, while in atmospheric-exposure tests atmospheres were uncontrolled.

1940


Atmospheric pollution as related to the weathering of stone and similar building materials is discussed, particularly the effect of SO, and its tendency to form calcium and magnesium sulfates with constituents of building stones commonly used in Britain. The fact that soot pollution renders many beautiful buildings unsightly is deplored. Though it must not be overlooked that there are various causes of stone decay, atmospheric pollution is undoubtedly an important factor. Its effects ultimately represent a considerable charge on the resources of those responsible for maintenance. Purification of the air would improve the appearance of buildings and extend the useful life of the materials employed in their construction. (JIT)


Among the many problems created by smoke and smog atmospheres are those of the corrosion of metals. Not all atmospheric corrosion is traceable to smoke, but it seems certain that polluted air, in the sense that it contains products of combustion, does actively affect the corrosion of metals. The Pillar of Delhi in India is cited as an example. This column of forged iron had stood in the dry, warm climate of India for centuries without appreciable corrosion appearing on its surfaces, but when it was moved to England as the property of the British Museum it was attacked by corrosion immediately, and the column is now reported to be in a very sorry condition.

The results of tests on a series of samples subjected to the smoke of industrial and low downtown areas and to that of the campus of Washington University, St. Louis, Mo., are discussed. Evidently, these pieces of structural steel and wrought iron were corroded less by the atmosphere of the campus, presumably because a less sooty and sulfurous fuel was burned in the immediate neighborhood. Weather conditions were approximately the same in both locations, and all samples were taken out of the same strip. The appearance of the samples during the progress of their corrosion indicated that the mechanism of the attack was identical for all of them. This is indicated in the curves showing metal losses. No checks were made upon either the soot or sulfur dioxide contents of the air at the two locations, although pollution in the two locations is known to differ.

A polluted atmosphere is, among other things, a waster of natural resources, and the estimates of annual cost of corrosion mentioned could be materially reduced by a cleaner atmosphere.


After 12 months' exposure an asbestos-cement pipe was scarcely affected, while a black iron pipe was heavily corroded. Both the lead- and zinc-coated pipes were attacked, the former in localized pits and the latter so uniformly that underlying iron had not been reached. (APB)


Attention is drawn to the possibilities of terra cotta as being the most satisfactory building material for with-
standing structural decay due to the action of atmospheric pollution. Investigations carried out by the Department of Scientific and Industrial Research, the results of which were published in 1928 (see B. S. A., 1929, No. 160), show that terra cotta, unless underfired, stands up well to exposure to town atmospheres. Terra cotta of the 19th century, in and near London and Italian terra cotta of the Renaissance period are still in excellent condition, although not specifically intended to be corrosion-resistant. The material also resists discoloration and disfigurement and is easily and quickly cleaned with soap and water. Copper must be taken in its structural use, discreet color contrasts being best combined with such features as recessed fenestration, projecting millons and bands, and modeller decoration in low relief. Carved-stone forms and strong colors are to be avoided. Terra cotta is best utilized now as a covering rather than as a load-bearing element. (FA)

1945


Five strains of H_2SO_4-forming bacteria have been isolated in pure culture from corroded concrete exposed to atmospheres containing H_2S. They are regarded as strains of a new species, provisionally named Thiobacillus concretivorus. (FA)

1946


Results are given of corrosion tests on low-carbon steels containing up to 18 percent of chromium carried out since 1941 in marine atmospheres at Kure Beach, N. C., and in industrial atmospheres at New York City and Niagara Falls. The specimens, of 16-gage sheet, were exposed at an angle of 30° to the horizontal. The Kure Beach samples were corroded uniformly on both sides. The others appeared to be more corroded on the earthward sides. Photographs and curves of weight loss against chromium content show that the amount of corrosion decreases as the chromium content increases. For 32 percent of chromium, the rusting is very slight, while with 18 percent, it is virtually nil. The marine atmosphere is, in general, less corrosive than the industrial atmosphere. Further tests were undertaken to study the effect of exposure on cold-rolled austenitic chrom-nickel steel. The change in weight, even after 5 years, was so small, the effect of corrosion was evaluated by tensile tests. Exposure to the industrial atmosphere of Niagara Falls for 5 years did not affect the strength or ductility of tensile test pieces. Spot-welded sections similarly exposed remained unimpaired in strength and free from permanent staining. (APB)

1948


The results of 10-year exposure tests of chromium and chromium-nickel steels, after various heat treatments and with various surface finishes, in an industrial atmosphere at Brackenridge, are summarized. Among the general conclusions are: (1) The corrosion resistance of high-chrome steels increases with increasing chromium content; (2) any increase in the chromium content above 18 percent or in the nickel content above 8 percent does not appreciably improve the corrosion resistance of chromium-nickel steels; (3) the modification of chromium-nickel steels with columbium, titanium, or vanadium does not improve the corrosion resistance in the fully annealed condition but does considerably improve the resistance of steel heat-treated at 1,200°F; (4) welding of the stainless alloys causes little or no decrease in corrosion resistance. (FA)

1947


An account of work carried out in connection with the regular inspection of painted steel structures and of open-air tests on samples of steel exposed under various climatic conditions to industrial atmospheres. (FA)

1947


One of the problems confronting civilization is the elimination of smoke from the atmosphere. An up-to-date survey of the principal aspects of the problem, together with the causes and nature of smoke and atmospheric pollutions, is presented. The book is in two sections: the first covers the influence of smoke on health, plant life, and destruction of property. Sixty million dollars would be required to make good the ravages of smoke over 25 years to the buildings of Britain. The second half enumerates what has been accomplished in the drive for cleaner cities and the plans to combat smoke. (FA)

1947


Except in coastal areas, dissolved CO_2 is the destructive agent in fresh air. City atmosphere carries CO_2 and tar acids. Bituminous paints give reasonable protection on clean metals but are not satisfactory for repainting old work. A mixture of equal parts of red and white lead is preferred for repainting. Galvanized wire has a short life at the seaside. Exfoliation is the most common form of attack on building stones; it may be due to crystallization of soluble salts beneath the surface or to differential expansion between the dense skin and the porous interior. Decay is hastened by using different kinds of stones in juxtaposition, for example, limestone against sandstone. Similarly, repainting old, porous masonry with dense mortar accelerates weathering. (APB)

1947


Proposes application of a powdered alloy containing 18 percent Cr, 10 percent C, 15 percent Mn, 2 percent Si, and 55 percent Fe to the blades to prevent corrosion caused by smoke. The powder is fused by the use of an electric arc. (FA)

1948


Sulfur dioxide in London air never exceeds 1 p. p. m. Leather-bound library books reduce the concentration in libraries, particularly in still air, because the vegetable-tanned leather rapidly absorbs sulfur dioxide from the atmosphere. The amount of absorption by the books can be determined, as can the state of deterioration from the action of the sulfur dioxide. Small variations will represent degree of exposure over a long period. The concentration of sulfur dioxide can be determined by the type of ventilation in the library as well as by the concentration of sulfur dioxide in the outside air. (USPHS)

The damp air of towns contains \( \text{H}_2\text{SO}_4 \) and a little \( \text{H}_2\text{SO}_4 \), which react with limestone to form \( \text{CaSO}_4 \), and especially \( \text{CaSO}_4 \cdot 2\text{H}_2\text{O} \). Gypsum is dissolved by water on the surfaces exposed to rain; the other surfaces blacken and become covered with incrustations, which break away and leave pittings. Compact stone with high thermal conductivity withstands the action of smoke well, but pitting appears if the index of porosity exceeds 13 percent. No direct correlation exists between mechanical and physical properties and susceptibility. The finest portion of the intergranular cement is more easily attacked than the compact grains. (FA)


The results of tests on the corrosion of ferrous wires when exposed in an industrial atmosphere for periods up to 10 years are reported. The rate of corrosion did not vary appreciably with duration of exposure but was affected by the diameter of the wire, being greater for thin than for thick wires. Certain wrought iron and low-alloy steels proved much more resistant than mild steel. The practical consequences of these observations are discussed, and considerable economies would be effected from the substitution of low-alloy steel wire for mild-steel wire, where resistance to atmospheric corrosion is required and other circumstances permit. (FA)


Examples are given of the deterioration of the leather of bookbindings and chairs when exposed to atmospheres containing sulfur dioxide. Analyses of bookbindings in London show up to nearly 5 percent sulfuric acid. Research over the last 20 years shows that keeping books in glass bookcases or coating them with a protective impermeable film will resist the rotting action of sulfur dioxide. (FA)


Discusses the menace of smoke pollution to buildings and the importance of this consideration in town planning. (APB)


The vulnerability of textile fabrics and furnishings to the acid products of combustion depends upon their chemical composition. This statement is amplified with reference to curtains, carpets, upholstery, and linen. (FA)


Corrosion trouble at a power station and the resulting investigations are noted. Steel stacks in position for 11 years were examined, and the \( \frac{1}{4} \) inch, mild-steel plates had rusted away evenly on the inner surface to \( \frac{1}{16} \) inch. The plates were analyzed and the results given. (AP)


A simple accelerated atmospheric-corrosion test is described in which specimens are subjected to corrosion in a warm, humid atmosphere containing sulfur dioxide. The experimental work was carried out with steam-heated apparatus, since replaced by a thermally controlled, electrically heated type. The effects of temperature and concentration of sulfur dioxide on rates of corrosion of bare and phosphated steel, with and without paint coverings, have been examined. Corrosion rates increase with rise in temperature and with increase in sulfur dioxide concentration. In bare steel corrosion tends to approach the maximum at an initial concentration of sulfur dioxide in the underlying solution of about 0.02 gm. per 100 ml., and the rate is approximately seven times that of steel exposed in the local urban atmosphere. Pretreatment by phosphating improves the corrosion resistance of painted steel, particularly when the paint coating is less than 0.5 mil thick. A thick phosphate coating, which does not conduct electricity and has therefore completely covered the basis steel, showed a resistance in outdoor-exposure tests much superior to that of bare steel. A method of determining the spread of rust by measurement of light reflection and effects of artificially damaging paint films are discussed. (FA)


The literature on the atmospheric corrosion of metals at various places in England and Germany is reviewed. The results of a study of the atmospheric corrosion of many metals at Berlin-Dahlem show that the rate of corrosion (1) depends on the purity and surface condition of the metal; (2) is related to the atmospheric conditions, decreasing with increase in temperature and increasing with rise in relative humidity and dewpoint; and (3) is related to the period of the year, reaching the maximum in December–February, falling to the minimum in June–July, and then rising again. Both (2) and (3) are shown to be due to the variations in sulfur content of the atmosphere, which is the maximum in winter and the minimum in summer, and the rate of corrosion is directly proportional to the sulfur content of the atmosphere. The metals studied could be divided into three groups: (1) Those that are almost completely corrosion-resistant, for example, gold, chromium, and stainless steels of the 18/8 type. (2) Those that are attacked, initially, somewhat readily but then become fairly resistant, owing to the formation of corrosion-resisting films which hinder further attack; this group includes aluminum, lead, zinc, brass, copper, nickel, and magnesium. With the exception of aluminum, which is relatively resistant to attack, these metals corrode at approximately equal rates during the winter, and the corrosion films grow at the rate of 1 to 10 \( \mu \) per year. (3) Metals that corrode somewhat rapidly, owing to the formation of nonprotective corrosion products (for example, iron). Rates of corrosion for this group are 1–100 \( \mu \) per year. (FA)


Results are presented for the corrosion of mild steel and aluminum-sprayed and bare aluminum plates. The experiments were carried out with atmospheres containing 0.2 to 6 percent \( \text{SO}_2 \) at temperatures of 300° to 700°. The effect of gas velocity, temperature, and concentration of \( \text{SO}_2 \) has been determined. Corrosion time curves for up to 40 hours' exposure are given for 0.2 and 4 percent sulfur dioxide-air mixtures at 900°. Small concentrations of water vapor in the gas decrease corrosion of mild steel, but further additions increase corrosion. The results show that the catalytic formation of sulfur trioxide on the surface of the metals is very important in determining the rate of corrosion. (FA)

It is shown that a mild steel surface can induce considerable catalytic oxidation of sulfur dioxide owing to the formation of FeO. The scale formed on mild steel exposed at 600° to gases containing sulfur dioxide contains ferrous sulfide, formed near the basis steel, and some sulfate, probably ferrous sulfate. Both aluminum-sprayed and aluminumized surfaces are considerably less active catalytically than mild steel after long exposure to sulfur dioxide at 600°. The presence of water vapor reduced catalytic oxidation considerably on all surfaces tested. The percentage increase is approximately inversely proportional to the gas velocity over the surface of the metal.

Reaction of sulfur dioxide and oxygen on a mild-steel surface is considered. Sulfdie and sulfate form simultaneously, the sulfide being concentrated near the surface of the basis steel. The rate of sulfate formation is greatest at 550° to 655°, corresponding to the maximum catalytic activity of FeO. Water vapor inhibits sulfide and sulfate formation but increases the rate of oxidation. (FA)


In the temperature range 15° to 40° C., at any value of relative humidity, the main factor in the corrosion of metal surfaces in an SO2 atmosphere was found to be the temperature. The maximum corrosion was observed at 20° to 25° C. at a relative humidity of 80 percent or more. Metals or alloys tested were soft iron, cast iron, aluminum, sheet iron, nickel steel, copper, and brass. (FA)

1939


Describes the extent of corrosion of steel in steel-frame construction of two buildings in Liverpool. The Bank of British West Africa, built in 1913, and the offices of the Royal Insurance, Ltd., built during 1907-1903, showed structural defects in the masonry covering of the facades, and renewal work on the stone and glazed brick led to the discovery of severe corrosion of the steel framework. The extent of corrosion in each side is described and the theories of the ways by which corrosion was affected are advanced. (APB)


In answer to an inquiry in Parliament as to whether buildings could be satisfactorily protected against the effects of harmful and noxious fumes emitted from oil-burning plants, the Minister of Fuel and Power stated that harmful sulfur fumes could be effectively eliminated. (APB)


The Lord President of the Council was asked whether he would procure and publish the available evidence of experiments made in recent years in America and Australia to discover whether buildings could be satisfactorily protected against the effects of harmful and noxious fumes emitted from oil-burning plants such as that proposed for the Bankside power station. In reply further details of the experiments were requested. The implication that the proposed oil-burning plant for the Bankside power station will emit harmful and noxious fumes was not accepted. The Minister of Fuel and Power stated on November 18, 1948, that the Government's technical advisers are satisfied that harmful sulfur fumes can be effectively eliminated. (APB)


Atmospheric corrosion of ferrous metals is closely related to the relative humidity and pollution of the atmosphere. Facts regarding its magnitude established by the work of the Corrosion Committee are reviewed, and the practical advantages to be derived from the increased resistance of low-alloy steels to atmospheric corrosion are considered, with particular reference to the use of paint and metallic coatings.


Review of the literature gives a general picture of the atmospheric corrosion of metals; some recent investigations at Berlin-Dahlem are quoted, which showed that the corrosion of metals in the winter varies directly with the concentrations of sulfur compounds in the atmosphere. In the first month of exposure lead, zinc, brass, copper, and nickel corroded at virtually equal rates and iron at about twice this rate. (FA)


I. After a brief assessment of the economics of the process, the distribution and nature, particularly the electrochemical characteristics, of atmospheric, underground, immersed, and anaerobic corrosion are described, and promoting and controlling factors associated with the metal and with the environment are considered. The influence of humidity and atmospheric pollution on the formation and breakdown of surface films is discussed. II. The field of corrosion prevention is covered in the following scheme: (1) Modifications of design or procedure—(a) design of structures, (b) surface condition, (c) cathodic protection; (2) modifications of environment—(a) water treatment (pH control, deaeration, etc.), (b) inhibitors for acid and neutral solutions, (c) inhibitors for wrappings and temporary protective coatings, (d) prevention in enclosed air spaces; (3) modifications of metal—(a) influence of purity and (b) corrosion-resistant alloys; (4) protective coatings—(a) natural and artificial films or coatings of reaction products, (b) paint and other organic coatings, (c) metal coatings, and (d) miscellaneous coatings. (FA)

1950


Results are presented of corrosion tests carried out by relatively simple methods. Free exposure to the outdoor atmosphere, the A. R. E. salt-spray test and a nonstreaming humidity test gave comparable orders of merit for several protectives on steel. Outdoor exposure is generally too severe and variable for testing oil films. A spray-on water-droplet test discriminated between oil films. Increasing protection with rising film weight of lanolin was demonstrated in an outdoor test. An appreciable reduction in the weight of steel corroded in the A. R. E. salt-spray test was produced by extremely thin oil films. (APB)


An accelerated atmospheric corrosion test, in which specimens are exposed in a thermostatically controlled humid atmosphere containing sulfur dioxide, has been applied to the assessment of temporary corrosion protectives. The protectives included materials ranging
from light lubricating oil, through petroleum jelly, to bitumen. The average order of failure of steel panels coated with the protectives, exposed in various parts of the United Kingdom in unheated sheds, approximated that obtained in the laboratory tests of one week's duration. A plain humid atmosphere was not agressive enough to break down most of the samples, in spite of a prolonged period of test. (APB)


The Acropolis of Athens is slowly crumbling away because the acid-producing sulfur dioxide polluting today's air is disintegrating its marble. The remedy is periodic washing with pure water. Previous centuries of pure air left Athens' marble monuments relatively untouched.

1951


Two problems concerned with air pollution—pollution by sulfur compounds and by smoke—are discussed. It is realized that the oxides and acids of sulfur in the rain cause damage to the fabric of buildings, to metal work, textiles, and other equipment as well as to vegetation and possibly health. Processes for the revival and recovery of sulfur from flue gas are discussed. However, no economic process has yet been developed for the removal of sulfur from flue gas.


Air sanitation plays an important part in assuring reliable reception and transmission in the nationwide network of microwave radio repeater stations developed by the Bell Telephone Laboratories for the American Telephone & Telegraph Co. Microwave energy is picked up at a repeater station, amplified, and re-broadcast to the next adjacent repeater station. These radio facilities are used to transmit broad-band communication signals involving hundreds of telephone messages and also to serve to distribute television programs on a nationwide basis.

Certain vacuum tubes, either in "cavities" or exposed in each equipment frame, require a steady stream of cooling air for the best operating efficiency. Each station has a single air-pressure source consisting of two multistage turbine type blowers. One blower operates from commercial a. c., and the second is a battery operated standby unit.

During the early development period of this project it was found that the temperatures within identical cavities were varying over a wide range. Investigation showed the temperature variations to be directly related to the quantity of air entering the cavities. Inspection of the cavities revealed comparatively large deposits of dirt in the air passageways and on the vacuum tubes which resulted in the restriction of air flow and gave every indication of complete stoppage under continued operation.

Analysis of the deposited dirt showed two conditions: the dirt was a coagulation of microscopic particles, and the sulfides in the air were combining with the silver plating of the inner cavity surfaces to produce silver sulfide. The result was a flaky layer composed of dirt and silver sulfide.

Although the initial design of blowers provided two filters, these were only capable of removing the heavier dirt particles and were for all practical purposes useless for removing the microscopic particles which were combining and being deposited in the small passage-ways where the air traveled at higher speeds. The necessity of correcting this situation led to the introduction of an efficient barrier type of filter material immediately after the original filter. This material has produced results in this application "comparable to that which would be expected of electrostatic filters."

These measures solved the dirt problem, and the solution to the second problem appeared to be one of supplying air free from sulfides. A filter was devised that effectively removes the sulfides from the air before being distributed to the various vacuum tubes. It consists of a bed of activated carbon 1½ in. thick, held between two meshed screens and supported in a frame.

The blower system has a maximum capacity of approximately 40 c. f. m. of air operating against a total static pressure of 5 in. water gage. When operating at this capacity it is expected that there will be less than ½ in. pressure drop across the combined filters.

ON VEGETATION

1874


Describes cases of utter destruction of vegetation and crops and advocates extension of Alkali Nuisance Prevention Act to apply to all industries. (MIR-Bib.)

1884


Findings of other investigators are discussed regarding the effects of smelter smoke on the vegetation in the vicinity of the Mulden Works. The investigators quoted concluded that the injury to the vegetation must be due to the SO in the smoke and the metallic poisons in the soil.

The conclusions are as follows:

(1) The areas affected by the furnace gases are certainly defined. Beyond these limits the injurious action will not extend in the future, because constantly increasing provisions for conditioning the noxious constituents are being made.

(2) In the district affected by the Mulden Works the injury not only has been diminished since 1880, but also since the taxation by the Committee in 1876.

(3) Münzner's machine-manufactory and wood-planing works in Obergruna has its part in the injury by furnace gases that appear in the Mulda Valley below Hohentanne and to the confluence of the Mulda and Bobritzech.

Although it is very difficult to express in figures the relative responsibility of the different sources of contamination, it is unfair to consider only the action of the smelter furnace gases.

1891


Injury from heavy fogs shown to amount practically to destruction. Safest conditions of the atmosphere during fogs were low temperature, moderately dry atmosphere, and diminished light, that is, the conditions most conducive to rest from growth. (MIR-Bib.)

Smoke from a factory in which phosphorite was prepared for the manufacture of superphosphate was suspected of causing injury to the pines and cultivated acacia and larch plants in a nearby forest. It was thought that the damage was due to sulfuric acid. However, examination by a factory official and a chemist was negative.

Another examination by the same chemist showed that the offender was hydrofluoric acid, and damages were paid for the injury to the forest. The phosphorite used contained calcium fluoride.


This valuable work extends preliminary report. Investigations included much microscopic and physiologic work and were especially concerned with forest contaminated with the products of coal combustion. Effects are compared with those of "pure country mists, uncontaminated by smoke." (MIR—Bib.)

1899


The lethal effect on vegetation was noted in this protest against the increased smoke over industrial areas of England. The combustion of coal is suggested as the answer to the smoke nuisance. (USPHS)


In 1893-94 an investigation was made of the cause of certain spots, especially on the leaves of mayflowers and roses, which resembled the effects of acid chimney-gases, but were not due to these nor to parasites, insects, frost, wind, and dry rot.

Experiments on a number of potted roses in 1898 showed that when treated with SO_4 and afterward exposed to the sunlight and air, the dead spots, extending through the entire twig, at first discolored, in 5 or 3 weeks turned brown or red, and consisted of air-filled collapsed cells with brownish plasma residues. The entire absence of the violet ring in all hitherto examined sulfuric acid spots is worthy of notice. The dead spots are always surrounded by a narrow blackish zone, in sharp contrast to the green tissue, and this dark boundary proves under the microscope to be free from violet. On rose leaves, an acid or smoke spot is to be recognized by its dark zone.

The injury due to chimney gases has been exaggerated. Sometimes in the early morning, with a southerly wind and heavy atmosphere, the SO_4 from the manufactories is noticeable and unpleasant in the hawthorn alley near the high school. The vegetation does not seem to have been injured, although the hawthorn is considered especially sensitive to smoke.

1900


Injurious substances and the difficulty of their detection are discussed. (MIR—Bib.)


Abstract of paper. (MIR—Bib.)

1905


Extensive observation and experimental work was carried on. It was concluded that sulfur dioxide, when present in the air in very small quantities, kills vegetation and that such injury shows itself by the increased sulfur trioxide content of the foliage. (USPHS)

1906


Shows soot to be chief enemy of vegetation in London. (MIR—Bib.)


The emanation of acid gases in connection with smoke and their evil effects is discussed.

The statement is made that the detrimental action of urban fogs on plants is due not so much to sulfur compounds as to deficiency of light, the cold dampness, and deposit of tarry substances, soot, and dust.


Relates to plant life of London, stating that it may be taken as a general rule that a London garden costs twice as much as a country garden of the same size, and this is entirely due to fogs and their constant companion, smoke. (MIR—Bib.)

1907


Probably the most important question confronting metallurgists and smelter men is that of the effect of "smelter smoke" on vegetation. Three well-known suits against smelters are cited: United States against Mountain Copper Co., an association of about 450 farmers in the Salt Lake Valley against four smelters, and the Deer Lodge Valley Association of farmers against the Anaconda Copper Mining Co.

A perusal of the literature on the smelter-smoke problem shows that it is the generally accepted view that the gas, sulfur dioxide, is responsible for the damage to vegetation and that the "fume" or finely divided solid emanation, containing arsenic, lead, and copper, causes sickness and death to animals.

A series of experiments was carried out to determine the average amount of sulfur dioxide in the atmosphere in the section of the country in the neighborhood of certain smelters. The conclusion was reached that, although some of the effects noted were produced by sulfur dioxide, which by no means is to be considered as harmless, heretofore undue emphasis has been laid upon the injurious effects of sulfur dioxide on growing plants and that the harmful action of the solid emanations from the smelters—the so-called "blue-dust"—has been seriously underestimated.


The research described by the author was on the grounds of a villa now completely surrounded by its neighboring city and near a large industrial establishment manufacturing many kinds of steel articles and employing more than 30 chimney stacks for power and process work.
The problem was to discover the cause or causes of the mortality of trees and plants on the grounds and to trace these causes to their origin. This investigation was pursued for 6 months. It was concluded from all the observations made that the acid gases in the atmosphere that killed the plants at the villa came from the adjoining works.

Before undertaking this experimental work an examination was made of the careful scientific works of the ablest French, German, and British chemists during the last 25 years, from which an annotated bibliography of 46 references was compiled and accompanies the paper. These references are also referred to and discussed by the author in connection with the various phases of his own investigation.


The smelting of sulfide copper ore releases three wastes that may be injurious to vegetation or animals. These are sulfur dioxide, arsenic, and copper. From the work at Redding, Calif., it is concluded that sulfur dioxide in very minute amounts kills vegetation. Such injury shows itself by an increased sulfur trioxide content of the vegetation for several weeks around the smelter is injured. From the work at Anaconda smelter, the conclusion is reached that vegetation is seriously injured 7 to 15 miles from the smelter. Junipers are very resistant, red firs are very susceptible, and lodgepole pines are intermediate. Large quantities of arsenic are discharged and are found in forage crops. Waste discharged into Deer Lodge River renders it unfit for irrigation purposes. (USPHS)


Takes exception to conclusions drawn by Ebaugh in article in Journal of the American Chemical Society (vol. 29, p. 951). Believes injury to vegetation to be due to the effect of sulfur dioxide. (MIR—Bib.)


The results of measurements of impurities at 10 stations are reported. Impurities are broken down into quantities of each type of contaminant, such as soot, tar, sand, minerals, sulfur dioxide, chloride, and nitrogenous matter. The tarry constituents were considered the most harmful to plants, and these were most highly concentrated in the residential districts. The total sulfur was found to be high everywhere, but particularly in manufacturing areas, and the sulfurous acids were considered to give to town fog its choking and irritating effects.

To demonstrate the detrimental effect of sulfuric acid on timothy grass, tests were performed in which the control grass was received acid-free water, while experimental plants were watered with ordinary rain water from Leeds and from Garforth. With Leeds water, the grass became yellow to brown, and this water was shown to have a high acid content. In the other plants where acid was absent or negligible (as at Garforth), there were no deleterious effects noted. (USPHS)

1910


Letter on damage to forests and crops by smelter smoke. Mention interference with railroads that present (1910) efforts at abatement have minimized the really serious damage. States that pines are much more susceptible than deciduous trees. (MIR—Bib.)


Results are reported of a study to determine the injurious effects of wastes from plants smelting sulfide copper ores may have on vegetation and animal life. Effects of sulfur dioxide on certain vegetation were first determined experimentally to see if sulfur dioxide was actually injurious and the type of injury it caused. Observations of actual damage were made around the Anaconda, Mont., smelter. In the experimental investigation, sulfur trioxide content in foliage was determined and compared with controls, and in all cases the exposed trees contained a higher concentration than the controls. In the field investigation, observations as to general appearance, types of growth, and sulfur trioxide content were made of foliage about the smelter. These observations were made during the summer of 1908. General conclusions included: (1) From actual chemical analysis it appeared that the forests extending at least 10 miles north, 11½ miles east, 9½ miles south, and 15 miles west of the smelter were injured; (2) it was noted that the junipers were very resistant to smelter fumes, while the red firs were very susceptible and were badly damaged at distances from 18 to 19 miles from the smelter; the lodgepole pines were damaged for at least 10 or 11 miles; (3) large quantities of arsenic were discharged from the smelter and settled on the grass of cattle ranges as far as 15 miles away. Such arsenical grasses are not a suitable feed for cattle. (USPHS)

1912.


Considers damage done to plant and animal life by fumes from copper smelters in Montana. Reviews injurious suit of Farmers' Association of the Deer Lodge Valley against Anaconda Copper Mining Co. (MIR—Bib.)


Deals mainly with conditions in region of Leeds, considered high amounts of suspended matter in town air and relatively high acidity of town rains. (MIR—Bib.)

1911


Investigations and observations (1906-10) at Manor Farm, Garforth, and Leeds are summarized. The work comprised analyses of rain samples and the effects of certain classes of atmospheric impurities upon vegetation. Rain samples were assessed for their impurities. Atmospheric pollution influences plant life by (a) reducing intensity of sunlight, (b) blocking stomatal openings, and (c) exerting a toxic influence through the sulfide constituents of the air. This influence affects the plant directly or indirectly through the soil.

Controlled experiments with timothy grass demonstrated that acidified water of 16 parts of sulfuric acid per 100,000 parts water, used for irrigation, proved fatal to the grass in little over a year. At 32 parts per 100,000 the grass died in 6 months, and no vegetation was visible the following spring. Other concentrations of lesser amounts were used, and it was observed that in every case the yield steadily decreased with increased acidity of the water. The effects in this respect were cumulative. Concentrations showing this cumulative effect compared with concentrations of acid in rain water falling in industrial areas. Thus, the
experiments were analogous to natural events, inasmuch as concentrations of acid in the water were comparable. The cumulative effect upon timothy grass resulted in a product poorer in protein, richer in crude fiber, and thereby less nutritious. (USPHS)

1912


Soft coal is the chief contributor to smoke, which consists of carbon, mineral ash, tar, moisture, sulfur gases, and acids of nitrogen, in widely varying concentrations. Smoke and soot constitute an extremely objectionable type of dirt. Smoke blocks the stomata of plants and hinders transpiration. By covering the leaf, it decreases the available surface exposed to the sun, and stunted plant growth is reported. Tar and acids have corrosive properties. Smoke affects the weather by (1) cutting off light, (2) increasing duration of fogs, and (3) increasing minimum temperature. (USPHS)

1913


The only remedies for this trouble are passing city ordinances that regulate the smoke nuisance and avoiding species like the elm, sugar maple, and others that are especially susceptible to gas poisoning. (MII—Bib.)


General observations and experiments were made and circular letters were sent to florists and gardeners in and near Pittsburgh in an attempt to determine the effect of soot in smoke on vegetation. The observations described show that soot is poisonous to vegetation. (18 refs. cited)


An experiment to determine which of the constituents of smoke produces a response in plants is described, the apparatus used, and the histological data discussed. Tobacco smoke is extremely toxic to many plants. It is evident that the smoke from the "cellulose and lignum compounds" (of tobacco plants) is rather toxic. The toxicity of tobacco smoke is due to the smoke of pure cellulose. Photographs show the stunting effect of smoke from cigarette paper on the growth of seedlings. Chimney smoke was found to be very slightly toxic. It was found that smoke from cigarette paper was 500 times as toxic as the coal smoke used. In general, the injury from coal smoke has been attributed entirely to tar and the oxides of sulfur. When smoke from cigarette paper is compared with carbon monoxide, it is found to be 10 times as toxic as pure carbon monoxide. The author seeks to show that reduced carbon-bearing gases are the major toxic factors in injuries from coal smoke.

Vegetation can be injured by gases undetectable to the gas analyzer because of their low concentrations. 1914


Studies indicate that two divergent results are brought about by the presence of soot in the atmosphere. One is beneficial and the other harmful to the life of vegetable micro-organisms. On one hand, soot has a definite bactericidal action on bacteria; on the other hand, it occurs in smoke, clouds, and fogs and as a transparent covering for streets and houses protecting micro-organisms from the destructive action of sunlight. From the bacteriological and hygienic point of view it may serve as a direct aid in propagating or preventing the spread of infectious disease. (11 refs. cited)

1915


Several fresh, vigorous plants (arbors vitae, grapevine, peach limb, and apple limb) were exposed experimentally to the action of sulfur dioxide mixture. No appreciable damage was observed except that the leaves on the grapevine were blighted.


At six stations, ranging from the heart of the industrial area of Leeds to a point 6 miles out of town, crops of radishes, lettuce, and cabbages were grown in wooden buckets sunk in the ground and filled with soil taken from common localities. A chemical and bacteriological examination of the soil at the end of the experiments, which lasted 3 years, showed that the detrimental effect of the smoky atmosphere on plant growth is partly due to such unfavorable changes in the soil as the steady depletion of the stock of calcium carbonate and the inhibition of the activities of the nitrogen-adopting bacteria. 1920


Extensive experiments have shown that concentrations of sulfur dioxide below 0.5 part per million have no injurious effect on growing crops or vegetation. For injury to result from this concentration, continuous exposure throughout the growing period would be needed with a high relative humidity of 80 to 100 percent. A concentration of 3 parts per million is necessary before the average individual can detect its presence. For sulfur dioxide to be an important constituent in air pollution, its concentration must be 0.5 or 1.0 p. p. m.

In this study 332 determinations were made. The highest concentration (0.8 p. p. m.) was noted on a foggy, smoky day with little wind. A table lists the results of the above study. 322 determinations, obtained from the upper level of the atmosphere were obtained by airplane. The results show that no heavy blanket of sulfur dioxide of high concentration was hanging over the city at any level below 3,000 feet. (USPHS)

1921


The variation in susceptibility in various types of plants to smoke damage suggested that carefully selected varieties might be used as indicators of smoke pollution. The conifer is considered the most sensitive plant, while hollyhock is considered the best indicator of smoke pollution. The general appearance of the exposed plants is discussed. The brown splotches and other changes in leaves are considered the best index. Other measurements are annual rings and chemical analysis of sulfur trioxide content in leaves. (USPHS)

1923


The injurious effect of smoke on plants, especially with reference to city parks and amusement parks, is more subject to the injurious influence of smoke, dust, soot, and gases than others, and plant
men have to change planting plans and select plants according to such unfavorable conditions. The list of trees and shrubs that are more or less immune to such conditions is very small.

As the smoke nuisance cannot be suppressed entirely, it is suggested that cities should be planned to provide the proper place for each activity, so that it can function in an advantage with as little interference as possible with other interests and needs.

1926


The changes in vegetation in the environs of aluminum plants and the unfavorable consequences resulting to the animals fed these altered products are emphasized. To show that the disease of the animals in the vicinity of these aluminum plants was due to poisoning by fluorine which was contested by the plants, a series of experiments was made.

When animals consumed a small quantity of the forage tainted by emanations from the aluminum plants, they contained more fluorine than normal and presented a cachetic condition leading to death. Although the presence of emanations of other toxic gases could play a role in the appearance of the disease, this was not necessary as the forage affected experimentally by the fluorine alone gave the same result.

1926.


Smoke is responsible for extensive damage to vegetation. Sulfur dioxide is formed from the burning of coal. Sulfur dioxide forms sulfur trioxide, which, combined with water, forms sulfuric acid, which in turn enters into the soil. The harmful effects of sulfuric acid on plants, vegetation, and trees are discussed. Animals feeding on smoke-affected pastures often do not survive. Some soils are so acid that they must be constantly limed. Plants affected by smoke appeared as though they had been dipped in hot water. The leaves brown and flowers fell off. Experiments were conducted, such as painting solutions of powdered metallic iron, red oxide in water, and sulfuric acid on plants. Marked damage was done by the acid, but there was practically no effect caused by the others. Tar products from inferior coal produce harmful effects on vegetation. The pyridine and phenol of tarry material appear to be unusually poisonous to plants. Fog also diminishes light to plants and thereby checks transpiration. (USPHS)

1931


Smoke causes detrimental effect on plants in three ways: (1) It blocks pores, impeding transpiration; (2) it coats the leaf, reducing transmission of sunlight; and (3) it is likely to exert a poisonous effect directly on the plant or indirectly on the soil.

For the first effect, the sticky, tarry ingredients are blamed. A film is created over the leaf, causing the second effect. Some of the methods for combating the smoke problem are discussed. (USPHS)

1934


Experiment: were carried out on the effects of sulfur dioxide on plants. The following observations were made:

1. Plants showed certain injuries that were characteristic for the species and for the age of the tissues involved. Leaves were not uniformly attacked. The middle-aged leaves were the most sensitive. 2. All other factors being equal, the amount of injury varied with the concentration of sulfur dioxide and the length of the fumigation period. Buckwheat was the most susceptible species.

It was most difficult to obtain uniform plant material. It is indicated that internal conditions at the time the plants are fumigated may control the entrance of sulfur dioxide and thereby affect the resistance of the plants. The degree of turgidity of the leaves was the most important factor. Wilted trees were more resistant than turgid plants because the epidermal pores were closed, and sulfur dioxide supposedly could not enter the tissues. Plants kept in the dark for several hours before fumigating were more resistant than those kept in the light. However, the wilted plants offered more resistance than those in a darkened chamber. It appears that the internal condition of the plants is more important than the external factor. (USPHS)

1935


Sulfur dioxide at a concentration of only a few parts per million may cause burned streaks and spots on the leaves; leaves or parts of leaves with a scant water supply seem to be the most seriously affected. Clogging the stomata by dust or soot is not as harmful, but it is a serious matter to have the surface of the leaves covered by a layer of dust, particularly dark-colored sooty matter that prevents light entering the leaf tissues. Under conditions existing in Pittsburgh, the resistance of trees to sulfur dioxide and dust is, in the descending order: Chinese tree of heaven, ginkgo, Carolina poplar, pin oak, London plane, liquidambar, Norway maple, the elms, and European linden.

1926.


This book is a study of the land of Great Britain and Its total utilization from the national point of view for agriculture, forestry, rural industries, recreation, and other purposes. Atmospheric pollution is condemned as a far worse enemy of agriculture than is generally thought, and it is pointed out that cleaning the air is a project that should be handled on a nationwide basis. (USPHS)

1936


Smoke may affect vegetation in the following ways:

1. The smoke decreases available sunshine.

2. The tarry matter coating over the leaves will tend to check, if not prevent, the natural process of transpiration and assimilation. Microscopic examination actually reveals choked stomata filled with the tarry material.

3. The presence of free acids in the smoke-polluted air lowers the vitality of plants. Loss of vitality is shown by poorer colors and reduced reproductive power as demonstrated by controlled experiments.

4. The effect of smoke is cumulative, through deposition of the acid in the soil, plants, roots, and other plants. The effect of smoke on various soils was determined by various plants and soil types.
a steady depletion of calcium carbonate and the inhibition of the soil organisms, particularly the important nitrifying ones. (USPHS)

1938


Experiments at Kew on the effect on vegetation of the deposition of an adherent scum on plants are described. When these experiments were begun, it was uncertain whether the damage was due to the low intensity of the light caused by the solid matter suspended in the atmosphere and deposited on the glass of the greenhouses or whether poisonous substances, such as the sulfur acids, were mainly responsible for the damage. To settle this point an ingeniously arranged apparatus was devised, in cooperation with chemists at the Government laboratory, to treat plants with sulfur dioxide in very low concentrations comparable with those that are known to be present in the atmosphere in foggy weather. With the aid of this apparatus it has been shown that small traces of sulfur dioxide are capable, under suitable moist conditions, to cause certain types of begonias to shed all their leaves in a single night in exactly the same way as they do during a severe fog. Very low concentrations of sulfur dioxide, such as may occur in a London fog, are also capable of inducing the buds of certain winter-flowering orchids to turn yellow and then black without opening. Experiments of various kinds, such as the application of apparatus for blowing a supply of filtered air into certain greenhouses, are being tried in cooperation with H. M. Office of Works to prevent the ingress of sulfur dioxide and related substances into the houses, but it is as yet too early to say which of these will prove to be the most effective and capable of the widest use. These researches have also shown how desirable it is that the chimneys of the furnaces heating the greenhouses should be as far away from the houses as possible, owing to the large quantities of sulfur dioxide that are evolved even when a smokeless fuel like coke is burned.

Apart from the harm that is caused in the above manner, it has been proved by other experiments that the low light intensity which prevails in winter, especially in foggy weather, is responsible for the poor development or premature falling of certain flowers, as well as for a general weakening of the plants. At Kew experiments have been made in which the normal inadequate daylight has been supplemented by artificial light from a low-tension neon tube that was placed in one of the greenhouses. It is uncertain whether neon light alone will ultimately prove to be the best form of artificial light for the growth of plants owing to its deficiency in blue rays; but, however, this may be, the preliminary experiments with this form of illumination have given very promising results.

1938.


Sulfur dioxide is the chief offender of smoke against vegetation. Sulfur dioxide poisoning causes red spots on the leaves, reddening of the needle termini, and lowered respiration. The deposition of soot, while not poisonous, interferes with respiration and excludes light. (USPHS)

1939


An extensive study made in Canada of the effects of sulfur dioxide on vegetation is described. The investigation was prompted by the numerous litigations of American farmers near the Trail, B. C., smelter, charging that smoke from the smelter spread in varying concentrations into a valley in the United States, thus causing undetermined damage to crops and other vegetation. This is a very complete treatise on the subject.

Part I describes the results of field studies: Sulfur dioxide in the atmosphere of industrial areas, symptoms of injury on plants, and crop plants and vegetation. Part II discusses fumigation experiments. (USPHS)


Most damage is done to crops and plants in the early part of the growing season when sulfur dioxide combines with high humidity. Symptoms of acute and chronic injury to plants are described. (USPHS)


This collection of 15 papers and a summary covers 8 years of field experience and fumigation experiments by a group of scientists from a number of opinion of the Trail Smelter Smoke. They were to obtain scientific data for the use of an international tribunal appointed to settle claims of alleged damage to crops in Stevens County, Wash., by smelter fumes from Trail, B. C. (USPHS)


The process of photosynthesis involves delicate and complicated chemical reactions under the influence of light. These reactions are readily affected by external conditions. Fumigation with 7.0 p. m. of sulfur dioxide caused about 95 percent leaf destruction of alfalfa. The plant rapidly oxidizes sulfur dioxide to a sulfate, which is the form in which plants use sulfur for their nutrition. (USPHS)


An investigation conducted by the National Research Council of Canada and reported in detail in the volume Effect of Sulfur Dioxide on Vegetation is summarized. The investigation is one of the series of investigations between the Governments of the United States and Canada regarding the harmful effect on plants, growing in the Columbia River Valley of Washington, of sulfur released by a large nonferrous smelter in Trail, B. C., 11 miles up the river.

The National Research Council of Canada undertook this study on behalf of the Dominion Government. Their investigation, from 1929 to 1937, represents an extensive and thorough study of the problem of SO2 injury of plants, a problem that has occupied the attention of agricultural and industrial interests for almost a century.

The actual concentration of SO2 in the air of the United States area under consideration was determined automatically and continuously for several years with Thomas autometers. The maximum concentration recorded for any 20-minute period during the growing season was 2.1 p. m. The average growing-season concentration was close to 0.07 p. m. Sulfur content of the vegetation, in general, was found to increase with proximity to the smelter. Water supply and soil were not affected. Measurement of annual rings of tree growth showed no retardation during the period under consideration. Experimental fumigation with concentrations, such as those prevailing in the area, failed visibly to injure alfalfa, barley, wheat, or coffee, and had no effect on protein, sugar, or starch content of field crops. Environmental factors were important in determining the susceptibility of plants to injury from higher concentration. Careful studies of photosynthesis and respiration showed that low-SO2
concentrations did not interfere with the assimilative processes. A common discoloration, known as "yellow top," which occurs on alfalfa in that area, had been ascribed to SO$_2$ but was found to be due to a boron deficiency in the soil.

These studies support the generalization that concentrations of SO$_2$ on the order of 1 p. p. m. will, in a few hours, injure sensitive plants growing under susceptible conditions, that higher concentrations may cause complete defoliation and death, and that lower non-marking concentrations usually have no appreciable effect on yield. (JHIT)

1940


Smoke adversely affects plant life in three ways: (1) By absorbing solar energy; in the worst cases as much as 40 percent may be absorbed; (2) by reducing the assimilatory power of the leaves, consequent upon the deposition of soot; (3) by the scouring effect on vegetation of the acids on plants by reducing the lime status of the soil. Attention is confined chiefly to the last point. The effect of the gases discharged into the atmosphere on trees, grass, wheat, and vegetables is described (ref., cited).


Plants were more resistant below 40° F. than above, and resistance decreased with increasing humidity, while poor soil and lack of water increased susceptibility. Wetting leaf surfaces had no adverse effect, but plants grown in the shade were definitely more susceptible than those in sunlight.

Sulfur dioxide concentration of 0.10 p. m.±0.02 p. m. were maintained for 25 periods, with alfalfa as the principal experimental plant. (JHIT)


The results of various studies on sulfur dioxide content in the air of cities in Great Britain and the United States are summarized briefly. Studies of the effect of sulfur dioxide on vegetation at Trail, B. C., are summarized. This and other investigations, surrounding the Trail, B. C., problem are considered to be the most valuable work on the effect of sulfur dioxide on vegetation. Sulfur dioxide is not always the cause of plant damage. A case is cited in which the yellowish discoloration of species of clover was believed to be due to sulfur dioxide, but later studies revealed that the actual cause was a deficiency of boron in the soil. The products from the carbonization of coal, of which ethylene and acetylene are the principal offenders, are stated to be much more deadly for plant life than sulfur dioxide. The importance of a careful study for all possible toxic factors in any investigation is stressed. (USPHS)

1941


Plants suffer injury when exposed to fluorine fumes from industrial plants. Fluorine may be found in plants that have been exposed to calcium fluoride powder. Plants, without exception, will show injury after exposure to fumes of fluorine; therefore, unless such injury is apparent, the presence of fluorine is of little significance. The microchemical detection of fluoride by the Ferlgi and Krumholz method is considered good, but Bredemann's method, based on the formation of sodium silicofluoride, is preferred. In several hundred analyses this method has never failed, and it is unaffected by fluoride present as a natural constituent of the plant. Plants almost a mile from the source of fluorine fumes are affected. This is a relatively small distance as compared with the effective range of sulfur dioxide. (USPHS)


Experiments were made with sulfur dioxide and similar atmospheric contaminants. It was found that plants will endure higher concentrations of sulfur dioxide in a relatively dry atmosphere than in a humid atmosphere. Effects of sulfur dioxide on plants and effective measures of protection are discussed. (USPHS)

1942


Many investigations of smoke damage during the last two decades have placed an overvaluation on the chemical analysis of the air in the neighborhood and have not given proper weight to the examination of the objects suffering from damage. Observations of damage to plants are important, and cases for SO$_2$ said to be the most widespread plant poison. In the case of dust, its As content is the determining factor as to the harm it produces. In the case of leaves the As content corresponds to the damage caused. Compounds of fluoride are important, as many plants are very sensitive to them. It is only when the actual damage to plants themselves is studied that an estimate can be made as to the harmful effects produced. This is of much more value than merely the testimony drawn from atmospheric analyses for SO$_2$. (CA)

1943


The harmful effects of sulfur trioxide, soot, fly gases, coke dust, water vapor, carbon monoxide, hydrogen sulfide, and tar and of mixtures are discussed. The greatest harm to cultivated plants was caused by sulfur trioxide and soot. (CA)

1944


The damage to vegetation in parts of Washington State by sulfur dioxide emitted by the smelters of the Consolidated Mining & Smelting Co. of Canada, Ltd., at Trail, B. C., has been the source of much international litigation for a number of years. In 1931, the smelter began to take remedial measures by converting a fraction of the sulfur dioxide into sulfurous acid. The problem to be solved is as follows: What atmospheric conditions in the valley will allow large quantities of sulfur dioxide to be emitted to the atmosphere without the possibility of damage to vegetation in Washington? The converse question also arose: What atmospheric conditions permit such high concentrations of sulfur dioxide that damage is caused in Washington? The aim of this investigation, ordered by the Tribunal, has been to determine these meteorological factors and to study their correlation with atmospheric diffusion processes that would provide a reasonable guarantee of protection against damage to United States interests across into International Boundary by emission from the Trail smelter. The first part of the report discusses the details of the plant equipment and procedure. The second part of the report discusses in detail the relationship between meteorological conditions in the valley and atmospheric diffusion processes. The third part gives the provisional operating regimes in force during
the investigation, the amount of sulfur fixed and the amount emitted to the atmosphere, and a summary of data from the permanent recorders. The final regime adopted by the Tribunal is described. (AEB)


The damage caused to vegetation by acid fumes (sulfur dioxide, hydrochloric acid, hydrofluoric acid, nitrogen trioxide, and nitrogen pentoxide) contained in the smoke from industrial plants is studied extensively. The best-known methods used for the determination of the sulfur dioxide in the fumes and in the plant parts are described. Several steps for preventing such damage were tested. Direct condensation of the fumes by compression and cooling, use of lower temperatures, decomposition with hydrogen sulfide, washing of the gases, and construction of high chimneys were all found either unsuitable or too expensive; while installation of numerous chimneys proved rather successful owing to a lower concentration of the escaping acid fumes. The best results were obtained with special installations based on the formula of Leachen:

\[ t = \frac{W_s}{(m_a/m_w)^n} \]

in which \( m_a \) = mass of air, \( m_w \) = mass of acid gases, \( t \) = time necessary to obtain a harmless mixture of gases, \( W_s \) = velocity of evacuation, and \( n \) = angle of divergence of the fume radius. The essential factor is to increase the quantity of gases by injection of air by a ventilating system, helped by a conically shaped chimney and insertion of a rotating device. This system can be preceded by washing of the gases. The entire problem is studied for Spanish conditions. (FA)


Analysis of soil, air, leaves or needles, and rain (or snow) water is necessary definitely to establish damage by waste gases. Bibliography is given. (FA)

1945


The effect of sulfur dioxide on vegetation, particularly with respect to the adverse effects on citrus trees, arising from increased industrialization in the Los Angeles area is discussed. (USPHS)

1946


Small plants (such as begonias and cinerarias) lose their foliage if allowed to remain in a smoky atmosphere for 24 hours. Exposure over a longer period results in browning, drooping, or discoloration of the flowers. (USPHS)

1947


The effects on plants are equally, if not more, injurious. The effects can be more adequately measured quantitatively and under conditions not possible with man or animal. The effects of polluted air are shown by a stunting of growth, loss of vigor, reduction in reproductive capacity, degradation of color, and death. There are four principal ways in which these injuries are caused: (1) Sunlight is an essential factor in plant life, and it is lost to the plants by the smoke above and by the coating of soot on the leaves; and the coating of soot on the leaves tends to choke the stomata through which respiration is conducted. This explains the fact that conifers are the first to succumb because of the characteristic sunk stomata forming an efficient trap for smoke; (2) the sulfur in the smoke comes in contact with the leaf, and some are probably absorbed through the stomata, causing damage to the living cell and destroying chlorophyll; and (3) sulfuric acid becomes deposited in the soil, and the effects are then cumulative over the years.

1948

1282. Hansard. Atmospheric Pollution (Sulfur), 1948, p. 86.

In view of the disputes current between many local authorities and the electricity commissioners as to the harmful effect of unwashed sulfur smoke on areas near power stations and as to the best method of its abatement, the lord president of the council was asked if he would instruct the Committee of Industrial and Scientific Research to investigate and report. He replied that measurements of sulfur pollution in the air are being made by the Department of Scientific and Industrial Research in many parts of the country, including areas near power stations, and smoke information is already available on the effect of sulfur on buildings and vegetation. The Department is already trying to find methods of removal of sulfur from the five gases of power stations that would be less costly and troublesome than those present in use. The problem is not an easy one, and a quick remedy cannot be expected. (AEB)

1948


Sulfur dioxide from industrial gases in low concentration is widely distributed in the atmosphere. In exposures of sufficient duration to concentrations higher than about 0.40 p. p. m. it may be toxic to sensitive plants at periods during the growing season when physiological activity is high and the conditions for rapid absorption of this gas by the leaves are at a maximum. However, low concentrations, in the range up to 0.10 to 0.20 p. p. m., have been demonstrated to be without influence on plant life, in the absence of visible markings. There is no effect, in this case, after long continued exposure on rate of growth, yield of crop, photosynthesis, respiration, or on the daily movement of the stomata. The effects may be beneficial if the plants are growing in a sulfur-deficient soil or nutrient. No basis has been found for the theory of invisible injury. The literature on the subject has been reviewed, and the results of investigations on various aspects of the sulfur dioxide pollution problem have been presented: Occurrence of sulfur dioxide in the atmosphere of industrial areas; sulfur content of vegetation; effect on soils; symptoms and diagnosis of injury from sulfur dioxide and other factors; retardation of diameter increment in conifers; experimental studies on the influence of environmental factors on susceptibility—the effects on conifers in natural habitat and on transplanted stock, yield of crop plants, stomatal behavior, and photosynthesis and respiration. It is hoped that the methods and results described will serve as a guide in investigations of effects of other industrial waste gases on plant life. (Author's abs.)


The brief findings are from 20-year laboratory, lysimeter, and pot-culture experiments on the chemical and biochemical behavior and the fate of fluorine after it is applied to soils through insecticides, fertilizers, crys- lites, rock phosphate, various fluorides and silico-fluorides, slag, rainwaters, and the atmosphere, par-
particularly the migration of the element from soil into vegetation. Through collaboration with TVA and two major manufacturing corporations, the experiments were elaborated to include studies of injurious effects upon plant and animal life purportedly resultant to fluorine effluents from two manufacturing operations in two widely separated locales in Tennessee. Soils were found to possess remarkably retentive qualities of the fluorine carried by insecticides, fertilizers, and various fluorine compounds, while yielding abnormal concentration of fluorides to the rainwater leachings from incorporations of electric furnace slag. Regardless of the nature and quantity of input of native fluorides or from the atmosphere, vegetation effected virtually no enhancement in the uptake of fluoride from soils that possessed adequacy of calcium, either naturally contained or added. Comparative analyses of crops grown on soils, in place and after transportation to unaffected points, served to support the conclusion that abnormal incidence of fluoride in field vegetation is attributable to atmospheric contaminants. (FA)


The extent of injury to the leaves of plants by sulfur dioxide is determined primarily by the amount of the gas absorbed through the stomata. The time-concentration relationships and the absorption leaf-destruction relationships are discussed with respect to environmental factors, such as light intensity, atmospheric humidity, and time of day, also with respect to stomatal apertures, and the carbohydrates in the leaves.

The effect on yield, due to various amounts and types of leaf destruction by sulfur dioxide fumigation, is shown to be the same as that due to equivalent leaf destruction by clipping off the leaves.

Sublethal dosages of sulfur dioxide may have no effect at all or only a temporary effect on the rate of photosynthesis of alfalfa, depending on the concentration employed. (4 refs. cited)


It is believed that man-made air pollution is at least partly caused by the upsetting by man of the natural cycle of assimilation and dissimilation. One of the most worthwhile contributions to smog abatement would be the organization of citywide composting of refuse, hedge clippings, leaves, and other combustible materials. Thus, smog abatement and soil improvement become two aspects of the same problem.

Improvement in the environment, air, and soil, can be accomplished by the processes that have maintained the equilibrium in nature for so many millions of years.


Studies at Boyce Thompson Institute are described in which plants were subjected to known gases under controlled experimental conditions to aid in identifying the characteristic effects of toxic impurities in the atmosphere.

On the basis of concentration, five gases studied can be listed in decreasing order of toxicity for animals as follows: Hydrogen sulfide, fluorine, chlorine, sulfur dioxide, ammonia. The order in decreasing toxicity for green leaves is fluorine, chlorine, sulfur dioxide, ammonia, and hydrogen sulfide. (23 refs. cited)

1950


The extent of injury to plant leaves by SO2 is determined primarily by the amount of gas absorbed through the stomata. The time-concentration relationships and the absorption-leaf destruction relationships are discussed, with respect to environmental factors, such as light intensity, atmospheric humidity, and time of day, and also with respect to stomatal apertures and carbohydrates in the leaves. The effect of SO2 fumigation on yield is shown. Sublethal concentrations of SO2 may have no effect, or only a temporary effect, on the rate of photosynthesis of alfalfa, depending on concentrations used.


The effect that atmospheric pollution has on plants is discussed. In large cities such as Los Angeles, brown patina is found on the undersides of leaves, making crops, such as endive or spinach, unsalable. Work done on the effect of air contaminants on plants is described.

1952


The ponderosa pine trees in the industrialized area north of Spokane, Wash., have exhibited a characteristic reddening of the needles since 1943, known locally as "ponderosa pine blight." The blighted area now embraces approximately 50 sq. mi., and the trees within a 3-sq. mi. area near the center are dead. As a portion of a comprehensive investigation, the concentrations of gaseous fluorine and sulfur compounds in the air during the growing season of 1950 have been determined through operation of 12 air-sampling stations and a mobile air-analysis laboratory. Analysis of rain-water samples obtained during each rainy period throughout the year and in November and December at 8 locations established the points of origin of the contaminants and the extent of their dispersion. Meteorological and topographical conditions in the ponderosa pine blight area, which control the dispersion of pollutants and explain the damage and pollutant concentration patterns, are discussed. Concentrations of gaseous fluorine compounds in the atmosphere of the area will serve as a guide in controlled fumigation of ponderosa pine. (13 refs. cited) (Authors' summary)


A strain of rye grass was treated in experimental greenhouses with polluted air and air that had been passed through a filter and water scrubber. Treatment with purified air gave a dry weight considerably higher than treatment with polluted air, although in the latter case there was no sign of leaf damage. Results indicate that pollution decreases the growth rate even in the absence of visible leaf injury. Concentration of sulfur dioxide in the polluted air varied between 0.01 and 0.06 p.p.m. (FA)
AIR POLLUTION—A BIBLIOGRAPHY


Report is presented on injury symptoms where 2,4-D had been used near plants.

The research project to determine the injury symptoms resulting from sublethal exposures to 2,4-D spray is discussed.

As a result of plant tests a chart is outlined presenting the order of activity of vapors of several 2,4-D esters as determined by plant responses.


Studies at the New Jersey Agricultural Experiment Station on the effect of atmospheric and soil fluorine on vegetation have led to the following conclusions:

(1) Plants obtain fluorine from the atmosphere and from the soil, thereby accumulating abnormally high fluorine contents resulting in fluorine toxicity.

(2) Fluorine analyses of leaves and roots of plants grown in New Jersey soils have supplied a means of distinguishing between fluorine coming from the atmosphere or from the substrate, inasmuch as the distribution gradient in the plant is characteristic of the source of toxicity. Atmospheric fluorine results in a high leaf and low root fluorine content; soil fluorine causes a high leaf and even higher root content.

(3) Studies have shown that plants vary according to species in the minimum concentration of fluorine necessary to produce visible injury, in their capacity for fluorine uptake, and in their relation between fluorine content and extent of injury.

(4) Nutritional studies in sand and solution culture have shown that plants in an optimum growing condition, with respect to supplies of N, Ca, and P, tend to be more susceptible to fluorine injury from the soil and, to a lesser extent, from the atmosphere than plants with unbalanced nutrition.

(5) In soil studies it was found that as the pH of the soil was increased, the degree of fluorine toxicity and the amount of fluorine absorbed by plants were minimized.

(6) Moisture was found to be of considerable importance in determining the extent of plant injury from atmospheric fluorine. Conditions conducive to greater degree of injury and fluorine absorption are high atmospheric humidity, turbidity of the plant, and wetting of the plant surfaces.

(7) Following an exposure to fluorine in solution or in the atmosphere, the fluorine content of plant leaves that was greater than could be accounted for from a dilution by growth.


Detailed description is presented of the observations and analyses made on plant materials exposed to known concentrations of fluorine for known lengths of time and also on vegetation growing in the vicinity of industrial works.

The problem of damage to vegetation is very complicated and is affected by many factors aside from the vegetation itself. These environmental factors include: the kind and amount of gases escaping; the direction and velocity of air movement; difference between surface and upper air; the distance and direction from the point of escape; the temperature and humidity of the air; the precipitation of gases from the air by rainfall; the intensity of sunlight and time of day when maximum concentrations occur; the availability of moisture in the soil; the duration of the exposure; and other factors.

The degree of damage to vegetation from a given concentration of specific gas in the atmosphere is influenced by the species and age of the plant, by the nutrition, health, and vigor of the plant, and by the position of the openings in the surface of the leaves, all of which are influenced by the environmental factors mentioned above.


Spinach, beet, endive, oat, and alfalfa plants were used for determining crop-damaging pollutants in the air of metropolitan Los Angeles. These investigations demonstrate the utility of plants in analyzing air pollutants. They further show for the first time that hydrocarbons, normally considered harmless air pollutants, can cause severe damage through their reaction with substances known to be in the air. (APB)


Fluorine toxicity in livestock may result from air pollution in areas surrounding industrial plants that utilize products containing fluorine and is caused by aerial contamination of forage with effluents from these plants. The occurrence and distribution of industrial livestock fluorosis have coincided with the development and expansion of certain manufacturing processes, principally in the phosphate and aluminum industries, although cement plants and enameling works may be involved to a limited extent. Information on conditions in areas surrounding other industries using fluorides appears to be rather limited.

The condition produced in animals is chronic rather than acute; thus, the incidence of fluorosis and the extent of injury to livestock will depend on the fluorine level that is maintained in forage over an extended period of time.

Feeding experiments are described, as well as the symptoms of fluorosis.

Control of industrial livestock fluorosis will require that the amount of fluorine emanating from industrial processes be reduced to the point where forage in the surrounding area will contain a fluorine level that is within safe limits.


Pollution of the air by sulfur dioxide in forest regions adjacent to smelting operations may gradually kill conifers by acute injury to foliage or retard growth. A mixed stand of Douglas fir and western yellow pine growing in their natural habitat was treated with concentrations of from 0.25 to 6.00 p. p. m.

The susceptibility to sulfur dioxide was found to parallel the seasonal variation in physiological activity of the leaves, being highest in the spring and early summer and lowest in the autumn and winter months. However, continuous treatment with 0.25 p. p. m. for 450 hours had no adverse effects during the insensitive period. The leaves were more readily injured in dry weather than in darkness during active assimilation. Injurious treatments caused a residual effect, which was manifested several years later by a retardation in growth.
Experiments were also carried out on transplanted conifers that varied in age from seedlings to 10 years. The trees were much more resistant to sulfur dioxide than those growing in their native habitat. However, the transplanted conifers also became extremely resistant to sulfur dioxide in the autumn and winter.

The deciduous conifer, larch, during its active growth period, was much more susceptible than any other species.

In the Columbia River Valley, Wash., the diameter increment of conifers showed a large retardation in growth during the period of maximum sulfur dioxide emission, within a zone 12 to 15 miles from the smelter at Trail, B. C., and smaller deviations as far as approximately 40 miles from the source of emission of sulfur dioxide.


Contamination of vegetation by air-borne fluorides may result from the following sources: (1) Soil of certain areas, (2) waste materials released from the stacks of factories, and, perhaps, (3) volatilization of fluoride-containing materials during the ignition of coal. Injuries to livestock have been attributed to the ingestion of food contaminated by fluorides originating from sources 1 and 2 but not from source 3.

Chemical data have been useful in evaluating the hazards associated with the release of fluorides into the atmosphere. Abnormally high concentrations of fluorides have been found (A) in the atmosphere and vegetation where animals grazed, (B) in the urine obtained from these animals during life, and (C) in tissues, particularly the bones, obtained after they were slaughtered.

On a farm adjacent to a factory that processed rock phosphate, evidence was found indicating that dust in the smoke emanating from the factory's stacks caused the occurrence of elevated fluoride concentrations in the surrounding area. These elevated concentrations were abnormal in the respects, A, B, and C, mentioned above.


A large plant for the manufacture of aluminum is located in Blount County of East Tennessee. Extensive operations for the processing of rock phosphate and slag are located in Maury County of Middle Tennessee. Both of the distinctive and widely separated operations emit fluorine substances in locales where livestock farming and dairying are long established and highly developed. Because of numerous claims that fluorine emissions now have become highly injurious to plant and animal life in both of the counties named, the University of Tennessee inaugurated a comprehensive laboratory and field study.

A major aspect of the survey is to differentiate the atmosphere and the soil as channels, whereby vegetation, forage crops especially, acquire abnormal incidence of fluorine in the locales contiguous to the operations. The chemical attack utilizes analyses of the atmosphere; field soils; experimentally treated soils; forage crops and other vegetation; exposed chemical fixatives and glass panes; rain, stream, and pond waters; rainwater leachings and the vegetation from inputs of various fluorine materials into fallout and crop residue.


From the viewpoint of one who is called on from time to time to diagnose cases of suspected injury to vegetation from phytotoxic gases, the reasons for some of the complicating factors are briefly discussed. Solely on the basis of symptoms, it is frequently not possible to differentiate between diseases due to living organisms and those due to gases. Chemically induced diseases may be confused with blights, scabs, scorches, leafspots, shot holes, tip burn, chlorosis, injuries due to drought, frost, insects, mineral deficiencies and excesses, cultural practices, and other causes. In identifying diseases due to gases the diagnostican should employ all of the techniques now known to be effective in identifying diseases of different causes including the use of the microscope, isolation and culture, and chemicals.


Fluorosis of cattle and leaf scorching of Italian prune trees and gladiolus have resulted from fluoride-emitting industries in Washington and Oregon. Characteristic leaf damages and large amounts of fluorine in the leaves were observed in these plants during operation of several factories known to emit hydrogen fluoride. Fluorine scourch of gladiolus can be controlled by lime spray under field conditions. At present an extensive investigation is being conducted into the cause of similar severe damage to ponderosa pine trees in Spokane, Wash., and vicinity. A number of factors may have a part in this damage, including atmospheric hydrogen fluoride from industrial sources, pine-scale infestation, and climatic factors. The method of approach to determine the individual role of the several possible causes is described, together with some of the current results.


The sources and symptoms of fluorine poisoning in animals are discussed. Diagnosis of fluorosis in animals should be made by a competent and experienced person and buttressed by laboratory analyses. Such a procedure would do much to eliminate the alarm and confusion that have prevailed in some areas without just cause.


The effects of sulfur dioxide on vegetation are reviewed.

Other important atmospheric contaminates that can cause injury to vegetation in particular places include hydrogen fluoride; sulfuric acid aerosols; and certain, as yet unidentified, greenhouse contaminants.

Types of foliar injury from smog as observed in the Los Angeles area are discussed.

Several gases—sulfur dioxide, hydrofluoric acid, chlorine, ammonia, hydrogen sulfide, mercury, carbon monoxide, unsaturated hydrocarbons, and growth-regulating substances—that commonly pollute atmosphere were studied experimentally to determine the characteristic injury caused and the comparative susceptibility of various species of plants.

Sulfur dioxide, hydrofluoric acid, and chlorine gases caused burning of dicotyledonous leaf tissue along the margin and often between the veins. Intervening spotting and burning were partially characteristic of sulfur dioxide. Hydrofluoric acid and chlorine caused marginal and tip burning of peach and other similar species. Monocotyledonous plants showed tip burn and often streaking at the edges and between the parallel veins.

Vapors of growth hormones like 2,4-D (2,4-dichlorophenoxyacetic acid) changed the growth habits of plants. Leaf pattern of leaves, flowers, and fruit were modified and distorted beyond recognition for the species. Damage of this sort has occurred around industries manufacturing hormone herbicides.

The range of concentrations of sulfur dioxide that could be tolerated indefinitely by sensitive species, such as alfalfa and buckwheat, was 0.1 to 0.2 p. p. m. Both of these species were spotted in 7 hours at 0.4 p. p. m. Chlorine had a similar effect. Some species tolerated 1.0 p. p. m. for 7 hours without visible effects. The critical concentration of hydrofluoric acid gas for the sensitive species was around 0.1 p. p. m. Middle-aged leaves were more susceptible than old leaves, and the latter more sensitive than young leaves.

When hydrogen sulfide was applied, the youngest leaves were injured first. Ammonia gas injured all leaf tissues equally at approximately 10 p. p. m. for a period of 7 hours. Mercury caused a special type of injury; the final result resembling somewhat that of ammonia, but the concentration of mercury in air was not determined. Carbon monoxide and ethylene gas caused a different type of injury. Carbon monoxide was effective at 1 part of the gas to 2,000 parts of air, while ethylene was effective at 1 part per 10 million parts of air.
METHODS OF DETERMINING AIR POLLUTION


It was planned to make simultaneous analyses from seven stations in Manchester and Salford to ascertain: (1) The comparative purity of air in densely and in sparsely populated districts, (2) the relation between atmospheric impurities and prevalent sickness and death, (3) the amount and distribution of noxious ingredients specially injurious to plant life, for example, SO₂, (4) the extent to which smoke and noxious gases are from (a) dwellings and (b) factories, and (5) the nature of fog and chemical character of air during the prevalence of fogs.

Snow carried to ground large quantities of HCl and H₂SO₄, also some elements of sewage. The amount of depositions on leaves was proportionate to population. The greatest injury to plants was due to emanations from dwelling houses. Two tons of "blacks" and H₂SO₄ were estimated to be deposited per sq. mile of city area.

1892

1306. STATIONARY ENGINEER. Density of Smoke. Vol. 11, 1892, p. 94.

Describes simple test for smoke density by carbon deposit on white paper, wrapped around cold iron bar or water-cooled pipe, and held in chimney. (MIR—Bib.)

1897


Two brass tubes about 5 feet long, with internal diameters of 1/4 inches and 3/8 inch, are placed one within the other. A slit is made through both tubes lengthwise to within 3 inches of end. Another cut is made at termination of slit at right angles to first. A semicircular plate is made to join both tubes at the end of the 3-inch cut. Paper is made to move across the slit at 4 inches per hour, and a copper tube inside the brass tube conveys cold water to keep the paper cool, since smoke will not deposit so easily on a hot as a cool surface.

The apparatus is then put into the chimney or flue, and the clockwork so attached as to keep the paper moving at a uniform rate of speed.

1894


Density of smoke on leaving chimneys is observed. (MIR—Bib.)

1895


A study was made of the atmosphere in Cleveland, with special reference to the constituents that may be present in the air from the products of combustion of fuels in the city. Methods of collecting samples and determining constituents are described.

From the results of this examination it is evident that a city atmosphere, contaminated by the universal consumption of bituminous coal, where no precautions are made to prevent the escape of smoke, reaches a stage in which it is destructive to property and not conducive to health. In this respect the atmosphere of Cleveland is, doubtless, no worse than that of other cities and, perhaps, in a better condition than some that use the same fuel. Under the usual conditions of life in cities, sanitary regulations require careful attention and constant supervision.

1896


By a series of elaborate experiments, the error of Uno Collan is asserted that the greater part of the sulfur in the ordinary, as well as in the nonilluminant, gas flame burns to SO₂. The tables give 88.27 and 81.90 percent SO₂ in a very luminous flame and 62.55 in a blue flame to 10.73, 18.20, and 37.45 percent SO₂, respectively.

1897


An experiment at Leeds roughly appraised the amount of solid matter at about 1 mg. in 100 cu. feet.

The first method, by appraising the air, using a Beckwith fan, and collecting dust on a glass plate smeared with glycerin, was found unsatisfactory.

The second method was by filtering a small and more carefully measured volume of air, weighing the solid matter as before. Two bags were employed, with an open zigzag tube coated inside with vaseline. Experiments were made to determine if the passage of the air current caused the vaseline to lose weight.

The result of 5 hours' aspiration of cotton-filtered air showed a loss at ordinary temperature of 1 mg.; in another experiment of 6 hours, 0.2 mg. With deduction of this loss, 100 cu. ft. of air was found to contain 1.36 mg. solid matter. In Leeds the average is 1.2 mg. per 100 cu. ft.

1898


To determine the density of chimney smoke a measured volume is drawn into a suitable glass tube containing asbestos, and the carbon estimated by heating the tube in oxygen or air and determining the CO₂. This is time wasting and is only adapted to a laboratory.

A glass tube, about 10 mm. in interior diameter and 150 mm. long, is filled with 2 gm. of loose cellulose (nitric cellulose). By a short piece of rubber tubing this glass tube is connected with another glass tube of the same diameter, the end of which extends within the interior of the chimney or duct. The other end of the apparatus is connected with an aspirator that draws in 10 to 20 liters of furnace gas through the cellulose.

165
At the conclusion of the experiment the apparatus is taken apart. The upper black cellulose layer is removed by a pincette to a wide-mouthed 300 cc. stoppered flask. Together with the partly colored remaining cellulose, both glass tubes are washed out so that the entire soot comes into the cellulose, which is then transferred to the stoppered flask, covered with 200 cc. of water and well shaken, so that a uniform gray-colored liquid results. To judge the amount of soot from the color of the fluid, it is poured into a round-bottom test tube 40 to 50 mm. in diameter, and the color compared with a color-scale previously prepared.

The scale is prepared by 3 gm. cellulose in each of a number of tubes containing 5, 10, 15, 20, 25, and 30 mg. soot to which 200 cc. water has been added and the tubes shaken.


Reference was made to various systems in vogue for determining the relative density or blackness of smoke delivered from factory chimneys, some of which were in use with official sanction in connection with the enforcement of smoke-prevention ordinances.

The system of smoke grading proposed by Prof. Ringelmann of Paris was discussed. This scale makes it possible to draw a line and state what will constitute good practice in smoke prevention.


Translation in full of the original article.

1899


Deals at length with nature and measurement of smoke. Considers the work of various commissions and smoke-abatement societies. (MIR—Bib.)

1900


The Austrian Society of Steam Boiler Owners of Vienna exhibits in the Austrian section in the Electrical Building of the Paris Exposition an interesting apparatus that indicates the density of smoke. The object of this apparatus is to indicate to the fireman the character of the flue gas, so that he may regulate his fire to obtain maximum combustion. But the apparatus has, incidentally, another advantage; namely, it enables the fireman to conform to the requirements of antismoke ordinances in cities where such regulations are imposed.

The device is illustrated and described in detail. It is made in a number of forms and may be adapted to various kinds of installations.

1906


An instrument capable of measuring and recording the density of smoke as it issues from the chimney is described.

The foundation of the instrument rests on the tintometer equivalent color-scales that have the power to match and record in quantitative terms the color sensation excited by any substance.


The necessity for establishing a suitable standard for city or town air is urged.

Reference is made to smoke-prevention acts that appear to give power to abate the smoke nuisance and then, by the use of certain limiting expressions, permit a loophole of escape.

1907


First of a series of papers on the chemical facts that make the solution of smelter-smoke problems so essential to the welfare of many extensive districts in the West, as well as some in the East and South, of the United States.

The determination of the constituents of smelter smoke is important for two reasons: Many of the constituents have considerable commercial value, while a large number are poisonous to plants and animals in varying degrees.

The work that led to the publication of this special article was the estimation of the amount of arsenic expelled from the world’s greatest smelter. During the last few years there have been numerous complaints from smelter districts that the trees and grass are not only injured in their growth by the sulfur dioxide and sulfurous acid of the smoke, but in some way the grass is also rendered poisonous for horses and stock, probably as the result of deposition of mineral poisons.

Details of the methods used in conducting the investigations are described. The amounts, in pounds per day, of the various constituents thrown off in the smoke are given. The general effects of high stacks in the amount of substances deposited and the distances they were carried are discussed.

1908


A short description is given of an instrument that is claimed to partially overcome the objections raised against the use of smoke-density charts.


Considers particularly the use of Ringelmann smoke chart and smoke gage devised by author for use with Ringelmann charts. (MIR—Bib.)

1909


A smoke indicator called a tintometer is described. The Ringelmann charts have a serious drawback, owing to the uncertainty as to whether the charts are illuminated by the same light, that is, the light illuminating the chimney head. To overcome these objections, the tintometer was constructed.

1910


Illustrates Ringelmann scale and tabulates some results of its use. (MIR—Bib.)


Brief description. (MIR—Bib.)


Apparatus is designed to give automatically a photographic record of density of smoke in a chimney during each minute of the 24 hours. (MIR—Bib.)
METHODS OF DETERMINING AIR POLLUTION


Describes arrangements of traveling laboratory for determining composition of chimney gases and atmosphere in different parts of Chicago. (MIR—Bib.)

1913


Describes apparatus devised by the Bureau of Mines. Of interest to engineers and chemists who have occasion to make combustion tests of fuels.


The Committee for the Investigation of Atmospheric Pollution, appointed at the International Smoke Abatement Conference and Exhibition held in London last March, decided that the method most likely to yield satisfactory results for the measurement of the impurities of the atmosphere was an apparatus resembling an enlarged rain gage, with a catchment area of 4 sq. ft. The observations and records given in the report should prove valuable to all interested in the progress of smoke abatement.


A committee was formed, with headquarters at London, to standardize and coordinate the diverse methods in use in various parts of Great Britain for determining the degree of pollution of the atmosphere by dust and soot.

The committee recommended the following two methods of pollution measurement:

1. A form of enlarged rain gage, having a catchment area of 4 sq. ft., receives all rain, soot, and other deposits in a large bottle provided to collect them. These may be analyzed each month, and the amount of solids estimated.

2. A measured volume of air is drawn through filter paper in a special apparatus, and the degree of discoloration of the paper measured. This method, which has been in use in Glasgow for about 2 years, is intended to give measurements of the solid contents of the air from day to day and from hour to hour.

1916


Describes results of tests of various instruments to determine accuracy, durability, and attention required.


The following types of apparatus for the measurement of city atmospheres are discussed and illustrated:

1. The standardized pattern of soot and dust gage employed for the observations in English and Scottish towns.

2. New form of recording actinometer that is automatic in action and makes a photographic record of the intensity sunlight over 12 hours.

3. The apparatus consists of a filterproper, two bottles, a rubber bung, with glass and rubber tubing, and a screw on the rubber tubes. Record papers are provided for taking observations.


A movement in behalf of the systematic investigation of atmospheric pollution in Great Britain began with a conference of delegates of municipal authorities and others held in connection with the Smoke Abatement Exhibition in 1912. A committee was appointed at that time to undertake regular observations. This body adopted a standard form of pollution gage—often referred to as a soot gage, but this name is inadequate as the gage measures other forms of atmospheric impurity besides soot. The gage receives and retains the rainfall of an entire month, and this is eventually removed, filtered, and analyzed. The amounts of tar, carbonaceous matter other than tar, insoluble ash, soluble matters, sulfates, chlorine, and ammonia are separately determined, and the values are reduced to metric tons per square kilometer. The first report of the committee, published some months ago as a supplement to the Lancet, contains detailed statistics for 39 stations for various periods of time and town maps showing the location of all the gages, of which there are 8 in London and 11 in Manchester. Of total solids found in rainfall, the greatest amount was deposited at Oldham, 35 tons per km.² per month. Ancoats Hospital, Manchester, came next, with 27 tons. The smallest deposit was at Maivern, 2 tons per km.² per month. If the records of these 39 stations represent the average condition of the air as breathed by the British population, it may be stated that the average atmospheric deposits upon a square kilometer in any one winter month 15 tons of solid matter, composed of 0.15 ton of tarry matter, 3 tons of other carbonaceous substances, and 6 tons insoluble inorganic dust, besides soluble salts, which includes 3 tons of sulfuric acid, a ton of chlorine, and 0.3 tons of ammonia.

1919


Describes gas-analysis apparatus and method of use; calls attention to economies that can be effected in the use of fuel.

1921


A method of sampling minute dust particles in air is described.

1922


Discusses methods of determining the percentage of fumes escaping into the air and the effect of humidity, light, temperature, and duration of exposure in connection with vegetation exposed to sulfuric acid fumes. (USPHS)

1924


Findings are based on original experimental data. A recording meter for atmospheric dusts is described. In this process the dust is continuously impinged on a slow-moving, transparent film, and, at the same time, the density of the deposit is recorded by photoelectric means. The original dust sample may be preserved indefinitely.

1925


All the methods used for sampling aerial dust are reviewed.
AIR POLLUTION—A BIBLIOGRAPHY

1926


The tables list the concentration of acetaldehyde that can first be detected by smell as being $96 \times 10^6$ molecules per cc. (CLAC/UCLA)

1927


Discusses the desirability of measuring instruments in the modern boiler room and includes a detailed description of a meter for the measurement of smoke density and an explanation of the manner in which such a meter may aid in the abatement of smoke. A discussion is included of boilers and boiler-room particles in attempts to operate at high efficiency and, at the same time, avoid trouble with the city smoke departments.

1928


Gives analyses of sulfur content of coal samples from different districts, analyses of sulfur dioxide and sulfites, and a survey of products of combustion taken from a furnace, and effects of coal gas on plants. (IH)


Discusses the most reliable methods for determining CO, CO, other acids (HCl, SO2, etc.), H2S, NH3, PH3, nitrogen oxides, O2, HCN, H2S, and hydrocarbons condensable vapors, and compounds in a vesicular state. Reference is made to the importance of the pollution of the atmosphere of large cities, particularly the presence of CO due to motor traffic. Experiments carried out at the Eifel Tower showed that the air in Paris is purer at ground level than at an altitude of 288 meters, and that, contrary to results obtained in New York (where up to 0.04 percent CO was found in the atmosphere of busy thoroughfares), the air of Paris was found to be very little polluted. (BH)


The sulfur content of the atmosphere is of economic, as well as pathological, importance. Fogs also are produced in industries where there are dumpy atmospheres and industrial plants are emitting sulfur dioxide fumes. It is suggested that sulfur concentration may have a definite relation to visibility.

Fulfilling a need for a method of determining very low concentrations of sulfur dioxide in air and the need for carrying and using such an apparatus in all weathers, a method and technique have been perfected, based upon that used by the Selby Smelter Commission. The method consists essentially of drawing the air sample into an evacuated bottle containing iodine starch solution that oxidizes the sulfur dioxide. The oxidized solution is then titrated to the same intensity of blue as a blank with standard iodine solution. Precautions are enumerated. (CLAC/UCLA)


Reports results of several tests made to determine temperature, humidity, and composition of tunnel atmospheres and their physiological effects on engineers.

1929


The increase of motor traffic has added to the quantity of soot particles in the air and to the need for more attention to air analysis with a view to the prevention of pollution. It is believed that the exhaust pipe of motor vehicles should open close to the ground, so that particles of carbon will settle there before they have time to become suspended in the air, which may be done. There are two methods of estimating soot in the atmosphere. The first depends on ascertaining the soot particles deposited on a measured enameled surface in a fixed time, and the second, estimating the particles suspended in a given volume of air. The soot collected by the first method is analyzed by ordinary chemical methods. This shows the quantity of unconserved fuel that is so injurious to plant life. The suspended soot particles are of special hygienic interest, owing to their interference with the penetration of the sun's rays and their entrance into the respiratory passages. Any apparatus that collects suspended particles in the air by condensation cannot be regarded as satisfactory for specially estimating soot, as other suspended matter is also collected. The colorimetric method depends on the blackening that is left by passing a known volume of air through filter paper.

A method is described that estimates the amount of carbon in a given quantity of air by pumping it through a tube containing a piece of broken quartz; the tube is then heated, and the CO given off is carefully estimated by titration. A table of results is given, which shows from 0.6362 to 0.1278 mg. of carbon per m. With the microscope, soot particles are found to vary in size from 54 to 50 μ.


The findings are based on original experimental data in addition to writings and experimental data of others. The diagrams illustrate the conclusions and should be consulted in the original paper. The conclusions are capable of practical application.


A smoke-density meter that can be used alone to indicate the combustion conditions within the furnace, thereby simplifying the adjustment of the furnace conditions to maintain the highest possible CO with a minimum of smoke, or the highest efficiency on combustion, is described. The instrument employs the conception that the measurement of density or ability of a medium to transmit light can be stated of density; that is, 100 percent density is total capacity of light transmission and 0 percent density is clear, or offering no reduction in the light transmitted.

1930


This report is the first by the Department of Scientific and Industrial Research after taking over the duties of the Advisory Committee on Atmospheric Pollution. The appointment of Dr. J. S. Owens as superintendent of observations and the cooperation of business concerns augur well for attaining the objectives of determining the nature and extent of atmospheric pollution, with a view to fixing public health standards in the streets.

The data published (on advice of the Permanent Consultative Committee on Official Statistics) are designed to stimulate public interest and cooperation by presenting comparisons between towns in a form readily intelligible to laymen.
Developments are foreshadowed in methods for (a) estimating sulfur in air and (b) recording intensity of sunlight by continuous automatic devices.

The report concludes with the detailed records from 81 centers for systematic observation. (BH)


At the request of the Atmospheric Pollution Research Committee, the National Physical Laboratory has designed an experimental instrument for measuring the total light received during a 24-hour period in two definite wave lengths, and the next step is to convert this into a suitable service instrument. It appears that the measurements will give fairly complete information as to both quality and quantity of daylight. The National Physical Laboratory has also been asked to investigate the determination of water in fogs.

Other research in progress includes: (1) The investigation of the effect of differences of exposure of the standard deposit gage on the deposits obtained; (2) the inspection of existing deposit gauges, so as to ensure that reliance can be placed on the results obtained; (3) the investigation of the Owens jet dust counter, with a view to establishing definitely the significance to be attached to the records obtained; and (4) the investigation of the measurement of sulfur impurities in the air. It has been found that, in Holburn at any rate, sulfur trioxide is not a normal constituent of the atmosphere; it appears only in fog.

The report on observations, dealing with results obtained with the deposit gage, shows there was an improvement in most stations, but a falling off in others. The question whether rain brings down atmospheric impurities has been considered in previous reports, and the conclusion reached that while the insoluble deposit apparently has no relation to the rainfall, the soluble matter varies with the quantity of rain. An examination of the data relating to 8 London stations over a 5-year period confirms this conclusion.

The relation of domestic to industrial smoke is discussed. Earlier reports have shown that in London the pollution consists of about 2/3 parts of domestic smoke to 1 of industrial smoke. In the present report the records for the winter months of five automatic filters in Glasgow are examined. The average ratio of the domestic to industrial smoke on average weekdays was 3.59, and on Saturdays, when factories close for the week, 11.7. There is considerable variation between the ratios at the different stations. Observations of the quantity of daylight received in Leeds and Salford indicated loss of daylight in the city as compared with the outskirts. The general deposit tables give detailed monthly figures of deposits for each station. (BH)


In 1926 the results of an investigation were published in which was shown, theoretically and experimentally, the inadequacy of the usual gravimeter methods for determining the dust inhaled by man.


Description, articles, correspondence, and drawings. (FA)


This model appears to simplify the standard Haldane apparatus satisfactorily by reducing the number of taps from 4 to 2.

The separate taps eliminated are those that, in the Haldane model, connect the absorption vessels with (a) the burette and (b) the outer air. Inside of them there is a neat three-way tap that connects the burette with either of the absorption vessels or with the outer air. This central tap is conveniently placed and thus enables the CO₂ absorption vessel and the thermobarometric tube to be placed on one side of it while the O₂ absorption vessel is located on the other.

Another special feature of this modification is that the junctions of the tubes of the central-tap piece are secured with the tubes of the absorption vessels by rubber tubing sealed with mercury, thus effectively preventing leakage. (BH)


The various methods of measuring smoke density that may be useful in connection with power-plant tests are described briefly. One of the most common objections to present methods is that smoke-density measurements, with all known methods except one, are affected by the diameter of the stack or gas stream in the case of a breeching. Readings should, therefore, be interpreted with judgment, based on local conditions, and have in mind the duty performed by the plant.


This volume contains the reports of (a) the Standing Conference to the Cooperating Bodies; (b) the Atmospheric Pollution Research Committee; and (c) the Superintendent of Observations.

In (a) mention is made in a reference to the provision of the Act of 1928 concerning bylaws regulating the emission of smoke, that it is difficult to obtain a convenient and reliable scientific measure of the density of smoke. Work at the Fuel Research Station has shown that, with the one particular type of boiler studied, there is a correlation between the optical intensity and the solid content of the flue gases. It has been decided to examine samples of smoke from other types of boilers to see if a similar correlation can be established in such other cases.

Progress in certain investigations is reported in (b). The National Physical Laboratory has completed its investigation on the development of an instrument for the measurement of daylight. The apparatus is easy to operate and furnishes an arbitrary measure of the relative intensity of radiation from the ultraviolet part of the spectrum and from a portion of the visible spectrum. From these data can be estimated the variation from day to day throughout the year in the total amount of daylight received during the period of observation, normally 24 hours.

Further work has been carried out at the National Physical Laboratory on the determination of water in fog, but certain difficulties yet remain to be overcome. Reports on two further investigations form appendixes to the report.

The report to the superintendent of observations shows that there has been a reduction in the amount of smoke discharged at about two-thirds of the stations. At certain stations estimates have been made of the pH value of the collected water. While the collections at Bournemouth and Cardiff were never acid and at Edinburgh seldom acid, the waters at Burnley and Marple were always acid and at Liverpool, Rochdale, Salford, Longton, and Wrexham usually acid.
Interesting figures have been prepared from the records of dust counts made by the U. S. Department of Agriculture Weather Bureau at American University, Washington, D. C. There appears to be a definite relation between the visibility and the product of relative humidity and number of particles per cubic centimeter. A curve is given that shows that the visibility varies as the logarithm of the reciprocal of this product.

Appendix I is a Report on the Determination of Sulfur Gases in Air. This report gives a useful review of previous work. A method is described for the routine determination of sulfur in the air. On clear or hazy days, the whole of the acidity appears as due to sulfur dioxide, sulfurous acid only appearing during fog.

The Distribution of Pollution Around Norwich, by D. Brunt, forms appendix II. The pollution was greatest in winter and least in summer. The amount of pollution measurable diminishes as the wind increases. The pollution reaches an approximately steady value, showing no further diminution, at a distance of 4 miles in spring, 5 miles in summer and autumn, and 6 to 7 miles in winter. The cloud of pollution is effective 4 or 5 miles wide, 3 miles from the city, which is 2 miles across. (BH)


Deals with some of the methods used in measuring smoke and sootfall and discusses their effectiveness.


Tests for odor intensity and nose and eye irritation were carried out on 55 substances in a series of 74 tests employing various concentrations of the different vapors in air. For this work an especially constructed odorimeter was employed to procure appropriate dilutions with air and by which to expose the subjects to the resultant mixture. A scale of intensity concentrations, as observed by the subjects, ranging from 1 to 5 was employed. The averages of observed odds and measured concentrations accord with Weber's law that the intensity of the sensory effect is proportional to the logarithm of the stimulus or concentration of the chemical. Excellent agreement in duplicate determinations of nasal and eye irritation, made with the aldehydes, at different times, was found, although the odor measurements did not agree as well. Aldehydes were not as effective in giving odors as were many other chemicals but were more effective irritants. (CLAC/UCLA)


The Leeds & Northrup smoke recorder is described.

1932


Describes briefly an instrument for recording smoke. In this apparatus, the smoke is measured by light deflected from the smoke particles, the light used is that scattered along the direction of the illuminating beam, in which direction its intensity is greatest. The source of light is a lamp of the type used in connection with talking pictures, the lamp being supplied with current at a voltage slightly below the normal to ensure long service. A particular advantage of lamps of this type is that they are made with the filament always in a definite position relative to the cap; no special focusing is therefore necessary when a lamp has to be replaced.


Findings are based on original experimental data. The Greenburg-Smith impinger apparatus, which was designed for sampling aerial dust, is described and illustrated. The information is presented at this time that persons requiring an instrument for the sampling of fumes, gases, smoke, or odors may be familiar with this device. It was found to be superior to the others tested at the Federal Bureau of Mines during the course of a detailed study of the sampling efficiencies of the various instruments available for this purpose.


Findings based on original experimental data. The design and construction of an apparatus for the sampling of atmospheric particulate matter is described. This device, known as the impinger apparatus, possesses the advantage of high dust catching efficiency when sampling air over the full range of dustiness (from relatively pure outdoor air to that found in very dusty coal-mining operations) at the relatively rapid rate of 2.53 liters (1 cu. ft.) per minute.


A modified form of the Greenburg-Smith impinger is described, and an investigation of its operation in sampling dust is reported.


Findings are based on original experimental data regarding a method that has been developed at the Institute of Hygiene of the University of Berlin. This method permits estimating quantitatively the total amount of carbon compounds not completely oxidized in the air.

1933


The mean monthly deposits of solid matter, as measured in the deposit gage, are given for the year ended March 1, 1932. These readings are from 42 townships in England, Scotland, and Wales, of these stations being in the London area. These readings represent the takings of 95 deposit gages, and automatic filters were used at 8 stations. Readings at Blackburn, Blackstone Edge, Kingston-on-Thames, and Oldham were taken for the first time. A general improvement is indicated when all stations are considered, the greatest improvement being in the deposit of tar, which was 22 percent of the general average, while the total solids were 86 percent.

Through the kind cooperation of Victor J. Asbe the result of deposit-gage measurements in St. Louis, Mo., have been made available for publication in this report. The quantity of the total solids deposited in St. Louis is exceeded by 11 British stations, and in 1 British
station the deposit is more than double that in St. Louis. (BH)

136.5. ENGINEER (LONDON). Instrument for Measuring Smoke Emission, invented by Dr. J. S. Owens, is described. A cross-section drawing of the instrument is shown and should be referred to for a clear understanding of its construction.


Light-sensitive cells and their use in the development of smoke-observation equipment are described. The action of a beam of light projected upon vapors demonstrates, if the particles of the vapor are possessed of reflective properties, such as water particles in a white mist or fog, that the deflection or scattering of the beam by the reflective and refractive action is the most useful effect for observation. In the case of smoke the interception of the light by the particles is the preferable observing feature.


The results of a series of sulfur dioxide determinations made of the air from 1927 to 1932 in Pittsburgh as a part of a broad air-pollution investigation are presented. Three sampling stations of 3 heights, 40 to 163 feet, were used. It is reported that on days that the fog cleared by afternoon, there was a decrease of sulfur dioxide. On days that fog persisted, the sulfur dioxide concentrations were increased. In all instances the levels of sulfur dioxide were low. The report concludes that the amount of sulfur dioxide present in Pittsburgh air is too small to be a cause of concern from a hygienic standpoint. (USPHS)


An abstract is given of two papers read before the Sanitary Inspectors Association (London Center) on May 31, 1933, and the differential experimental methods used to ascertain the density of smoke are reviewed.

136.9. BRITISH DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. Smoke from Chimneys; chap. in Investigation of Atmospheric Pollution. 10th Rept., London, 1934.

Further work has been done on the photoelectric instrument proposed to measure the optical density of smoke clouds arising from the chimneys; a review of this method is presented. Light from a small area of sky is compared in intensity with light from a part of the smoke cloud. It is recognized that by such a method confusion may be caused by the differences in color of various smokers, the smoke from cement works being cited. It is observed that a new problem in the control of smoke, or ash pollution, may be introduced by the increasing use of pulverized fuel; the apparently harmless clouds of white smoke, resembling steam, seen over the chimneys of certain power stations are sometimes composed of minute hollow globes of glass-like substance whose effects upon the world in general are at present unknown. (BH)

137.0.硫磺污染; chap. in Investigation of Atmospheric Pollution. 10th Rept., London, 1934.

Results obtained in measuring the degree of sulfur pollution by means of new apparatus described in a former report are given; this new method is considered to be a success, but it is not yet out of the trial stage. Two methods for the measurement of sulfur pollution are employed now. They are the volumetric method and the lead peroxide cylinder method; the last named has the advantage that a measurement of the "activity," that is, the destructiveness upon stone of the sulfur compounds is obtained. (BH)

137.1. THE INVESTIGATION OF ATMOSPHERIC POLLUTION. Report on Observations in the Year Ended March 31, 1933, 19th Rept., London, 1934, 90 pp. Results are given of observations taken with 91 deposit gages, 13 automatic filters, and 11 sets of apparatus for determining sulfur gases in air. Of the total number of deposit gages only 48 can be included in the summary as having "general averages." These are summarized in the report of the Director of Observations.

A graph of total solids deposited compares the total deposits at 51 stations during the current year with the general average for the last 5 years. This graph shows a general drop in deposit, but in six stations there is a significant rise indicated during the current year, namely, at Birmingham, Stoke-on-Trent, London (Archbishop's Park and Ravenscourt Park) also at Liverpool. Variations in lime and in the pH value of deposits are noted. (BH)


Short historical review of the public interest shown on the question of atmospheric pollution and its measurement.

Attention is directed to the large influence of the domestic open-grate fire in the production of smoke, and an interesting separation is made of the effects on atmospheric pollution in Glasgow. The conditions of the air on Sundays and weekdays are compared; practically all the smoke on Sundays is due to domestic fires, while on weekdays the effects of domestic and industrial fires will be evident.

By comparing the readings of fire Owens automatic air filters it was found that on Sundays the smoke density during the summer was 82.2 percent, in the winter 81.4 percent, of the weekday smoke in Glasgow, striking evidence of the ill effects of domestic fires in causing smoke pollution. A criticism is the possibility that considerably more smoke may be produced domestically on Sundays than on weekdays, owing to the greater amount of midday cooking and the lighting of parlour fires on this day.

Some interesting charts and also reproductions of automatic air-filter records are given. (BH)


Findings are based on original experimental data.


Findings are based on original experimental data. Describes the adaptation of an inexpensive electrically driven automobile tire inflator to function as an exhaust pump for a dust-analysis apparatus.


This report on the investigation of atmospheric pollution is based on the readings taken in 43 localities, 7 of which are in the London district. In all 96 deposit gages, 14 automatic filters, 12 sets of volumetric apparatus for the measurement of sulfurous impurities, and 34 sets of lead peroxide apparatus for the same purpose were used.

The difficulty in comparing the deposit-gage readings of any given year with a general average is again discussed.

The chairman of the Standing Conference to the Cooperating Bodies for the year 1933-34 states:
This report is based on observations in 44 provincial districts and 9 stations in the London area. The observations were taken with 93 deposit gages, 11 automatic filters, 11 sets of apparatus for determining volumetrically the sulfur gases in the air, and 37 lead peroxide sets for estimating the activity of sulfur in the air.

In the last report the need for a further statistical examination of all previous deposit-gage readings was pointed out. The present report contains an analysis of previous deposit-gage readings extending in some instances, over a period of 20 years. The difficulty found in determining the trends of changes on account of the large effects of rainfall is pointed out. There is little evidence of a diminution in the insoluble components of atmospheric pollution over the period, but the soluble components show a marked fall during the first 8 years of the records, both at Glasgow and with two exceptions at London. A theory is advanced that there have been changes in the quality of domestic coal burned.

The general inference for the year under consideration is that atmospheric pollution was slightly worse than that shown by the general average of the stations. An exception to this trend is evident in respect of tar, in which 28 stations showed a decrease while 36 showed an increase and 14 showed no change.

New Development.—In industrial areas it is considered that a special investigation, larger than any hitherto undertaken, should be made to obtain more complete information concerning the nature and extent of pollution in industrial areas. To this end a large number of recording stations will be needed both in and around a given industrial area.

Sulfur Pollution.—The lead peroxide cylinder method previously described has been increasingly used during the past year. The Committee is considering the desirability of taking hourly records of the concentration of sulfur gases in the air.

Daylight.—Further experiments have been made to develop the photoelectric recording apparatus mentioned last year.

Carbon Monoxide in the Air of Streets.—A standing conference of representatives of cooperating bodies has decided that at present there is insufficient evidence of ill effects solely attributable to the inhalation of carbon monoxide present in the air of streets on which to justify further research. (BII)

1936


A natural and easy way to determine sootfall and other impurities is to observe the deposit of smut on the snow. In the instance cited during the snowfall at Leeds, England, smoke, after aggregating to form smut, agglomerated, then disintegrated and broke down to form dust. Also, as the air was still and conditions typical for cold weather in the neighborhood and smuts were held in situ where they fell, it was easy to calculate the typical winter smoke deposit per morning per unit area by finding average smut weight.


In the pursuit of research on smokeless briquets, it became desirable to develop a quantitative measurement of smoke. Such a method of measurement permits the accurate determination of the smoke of naturally occurring coals of various volatile matter content and of briquets impacted from coal fines processed to various volatile matter content.

Comment is made on the 21st annual report on air pollution observations in England that shows that 44 local authorities and 6 other bodies interested in the measurement of air pollution were engaged in making observations under the Department of Scientific and Industrial Research during the 12 months ended March 31, 1935.


Discusses (1) the apparatus and methods used for the measurement of air pollution, (2) the comparative position of the towns and cities in which these observations are being made, as indicated by the figures in the last report, and (3) the relationship between atmospheric impurity and electrical supply. These three subjects are discussed insofar as England is concerned.


A general article on the origin and history of the Ringelmann chart.


A general survey is presented of measurements of air pollution that have been systematically carried on in England during the last 10 years. The investigation is under the direction of the Department of Scientific and Industrial Research.

1937


The report is based on observations in 47 provincial districts and 7 stations in the London area. The observations were taken with 110 deposit gages, 11 automatic filters, and 11 sets of apparatus for determining volumetrically the sulfur dioxide in the air by means of the lead peroxide method. The total number of stations in operation shows an increase over the previous year.

Report by the Superintendent of Observations.—Deposit-gage readings are tabulated for every station and compared with the general average, and the natures of the deposits obtained are commented upon at length. Automatic filter records are discussed, as are the results obtained by the two recognized methods of determining air pollution. Daylight measurements, by the potassium iodide method, were made only at Halifax, Leeds, and Glasgow. It has been decided to continue the use of the Hill-Webster method for measuring ultraviolet radiation (by acetone methylene-blue) until a more satisfactory method has been obtained.

The Department keeps in touch with the United States Treasury Department, the United States Public Health Service, and Dr. B. Tanaka of the Hygienic Institute, South Manchuria Railway Co., to compare the apparatus used and results obtained.

General Findings.—Making allowance for the effects of the industrial depression years 1929 to 1933, it is believed that the smoke abatement has had a real effect. Curves of total deposits taken at stations, with long records, support this contention.

The percentage of winter sunshine experienced in London compared with that at Kew has risen from 20 percent to 52 percent since 1881.

It may be concluded that a definite reduction in the extent of pollution of the atmosphere in Great Britain has been made during the past 20 years.

New Methods Under Investigation.—The proposal to measure daylight by photoelectric methods is likely to be discarded in favor of a cheaper form of daylight photometer now in course of development.

The Variation in Sulfur Dioxide With Wind Direction at Any Station.—A new lead peroxide apparatus has been made and successfully tested. In this apparatus eight sectors on a vertical cylinder under the control of a wind vane are exposed to the air. Photographs of this new instrument and of the ordinary lead peroxide gage are included.

Condensivity of Rain Water.—This quantity is of interest when considering certain difficulties found in the statistical study of deposit gage data covering a number of years. An apparatus for measuring the conductivity of rain water has been constructed, and trials under working conditions will be made when opportunity offers.

The Determination of the Relationship Between the Optical Density and the Mass of Dust Stains.—Experiments are in progress to establish this relationship. It will be remembered that comparison of the optical density of dust stains is the index used in the Owens automatic filter.

Hourly Values of Sulfur in the Air.—These measurements are the subject of experiment.

Full Investigation of Pollution in and Around an Industrial Center.—In the last report reference was made to a proposal for a very full intensive investigation into the factors affecting pollution in and around an isolated industrial center. This work is now to be done at the city of Leicester. (BH)


The use of the deposit gage for estimating air pollution is discussed. Although this method has been useful, it does not deal with the extremely divided suspended matter, which sometimes is termed an aerosol or suspensoid. To estimate the amount of particulate matter dispersed through the air, two types of apparatus are described. One uses white filter paper to determine the concentration of smoke pollution of city air; the other determines the concentration of sulfur dioxide present in the air by absorption and fixation, as sulfuric acid is an aqueous solution of unstabilized hydrogen peroxide.


Results are given of measurements of air pollution over a period of 6½ years by Stevens Institute of Technology, Hoboken, N. J. The object of the survey was to determine from where the dirt was coming, rather than merely to know the dirt in the air at any one place and time. This information was obtained by observations over periods of 6 months each of the direction from which smoke was coming from each of the 8 cardinal points of the compass.

Details of the instruments used and reproduction of rose charts and graphs are illustrated by 18 slides. The slides also show the remarkable achievement by the Department of Smoke Regulation in smoke abatement on the New Jersey side of the Hudson River.


The more general types of apparatus for measuring the quantity of entrained flue dust in the gases of coal-fired plants are considered, with special reference to their application and limitations.


Findings are based on experimental data of others. The conclusions are apparently capable of practical application. The photographs, figure, etc., are essential to an understanding of the data. The original paper should be consulted.

The findings are based on original experimental data in addition to writings and experimental data of others. Conclusions capable of practicable application are reached.

An apparatus for quantitative field sampling of chlorinated hydrocarbons in air by combustion and adsorption in sodium carbonate solution is described.


In some investigations of the respiratory activity of leaves, using the absorption or excretion of carbon dioxide by the leaf as the criterion of activity, it was necessary to construct a hand-operated apparatus that would determine the carbon dioxide content in 2.5 liters of air, with a maximum error of 2 percent and an average error of approximately 1 percent of the atmospheric concentration, and allow 2 or 3 determinations per hour.

1938


A procedure was developed that made possible the sampling of the exhaust gas mixture within each individual cylinder of a multicylinder internal-combustion engine. A combination spark plug and sampling valve, inserted in place of the regular spark plug in any cylinder, is used for the sampling. The valve is actuated by a small solenoid coil that receives its current from an auxiliary breaker mechanism. The valve is opened momentarily to accept samples at such time as can be regulated by the auxiliary breaker. Samples are drawn into an evacuated gas-sampling tube that can be sent to a laboratory for analysis when filled. (CLAY/UCLA)


Describes application, accuracy, precision, limitations, construction, and operation of modified Haldane gas-analysis apparatus used by Bureau of Mines for determining small volumes of carbon dioxide, combustible gases, and oxygen with degree of accuracy not attainable by ordinary gas-analysis methods. Also includes methods of calculating results of analysis, comments on use and care of apparatus, and discussion of causes of difficulties most commonly presented in using apparatus.


This is based on observations in 54 provincial districts and 7 stations in the London area. The observations were taken with 136 deposit gages, 15 automatic filters, 14 sets of apparatus for the volumetric determination of sulfur gases in the air, and 45 sets of apparatus for estimating the activity of sulfur in the air by the lead peroxide method.

The above numbers of instruments in use all show increases over those of previous years.

Several new deposit gages are now in use in country districts for the first time, and these are expected to give interesting comparisons.

Tables show the numbers and kinds of apparatus in use in different localities and the changes that have been made during the year. The presence of chlorides in deposit gages raises the question of differentiating between chlorine coming from land sources and that due to finely divided sea spray, the last named can form condensation nuclei for rain drops.

Deposit gage figures are tabulated for comparison with a general average taken for the 5 years ended 1932.

The general tendency shown is toward an improvement in atmospheric clarity, there being fewer stations in the C (dirtier) class and more in the A and B (cleaner) classes than previously. (The notation refers to an arbitrary classification of stations in terms of weight of deposit per unit area.) There has, however, been little change from 1930-31 to the current year.

Detailed comments on the findings from deposit gage readings refer to tar; carbonaceous matter other than tar; insoluble ash; soluble loss on ignition and ash; topsoil; and chlorides and ammonia. Measurements of the amount of lime in deposits, also of pH and alkalinity of deposits are recorded. Daylight and ultraviolet radiations were also measured and recorded.

A new form of daylight photometer has been produced, based on a combination of Bennett integrating spheres and a photographic method of measurement using a silver-quartz, ultraviolet filter and a gelatin wedge. This apparatus, still in the experimental stage, has the advantages of simple operation, low cost, and an inclusion of light from the whole sky, and the measurement of ultraviolet radiation over a narrow band.

An apparatus for making hourly records of sulfur-pollution measurement has been somewhat modified and is now in use in the Leicester investigation.

Directional lead peroxide gage measurement has been the subject of a report from the Building Research Station and gives promise of useful application.

An investigation of modifications of deposit-gage readings by bacteria as a possible source of error has so far shown it to be negligible; but the research will be continued over a period of hot weather, when effects of any such action may be expected to be most apparent.

The intensive local study at Leicester of the atmospheric pollution in and immediately around a relatively isolated industrial center is now in full operation, with the active cooperation of the city of Leicester.

Details of the 12 stations in and around the city are given in an appendix, with a map of the district. To make this investigation complete full meteorological data are necessary—to be correlated with the data on pollution. This need has been met by the setting up of meteorological stations by the city authorities.

The report draws attention to the possibility of fallacious comparisons being made between the atmospheric pollution in different towns by overlooking what may be vital differences in the sites of the instruments.


Describes the procedure used by the Bureau of Mines in determining, by the impinger method the number concentration of dust in industrial atmospheres. The method consists of the collection of dust in a liquid medium and the counting under the microscope of the particles in a known portion of this liquid. Included in the paper are schematic drawings of six types of impingers used by the Bureau, with descriptions of each. Various types of suction mechanisms and of microprojector assembly, which facilitates particle counting, are pictured. Descriptions of these devices, their methods of use, and types of liquid collecting mediums are given.

The impinger method indicates the approximate number concentration of insoluble microscopically visible
solid particles in the sampled air. Collecting efficiency of the impinger is over 90 percent for dusts of particle size larger than 0.5 μ in diameter. Impinger results are, however, not empirical or quantitative. (CLAC/UCCLA)


Describes microprojection technique for counting im-pinger dusts. Method is essentially the same as regular microscopic method, causes relatively little eye strain, and is more rapid in that it permits more concentrated samples to be counted without secondary dilution.


New method for measuring smoke density by indicators or recorders installed in a power plant.


Reviews briefly use and limitations of photometric microscopes and method used by Health Division, Bureau of Mines, to determine composition of air-borne dust, a procedure frequently desirable in estimating hazardous qualities of a dusty atmosphere.


The findings are based on original experimental data. The conclusions are capable of practical application. The tables and figures illustrate the conclusions and should be consulted for a proper understanding of the paper.

The result is reported of an investigation of some of the operating characteristics of the Bausch & Lomb dust counter. This dust counter is in principle an Owens jet dust counter with several features added, designed to make it a more practical instrument for general field use. The essential features of the Bausch & Lomb device are: A pump, a moistening chamber, a slit 6 by 0.4 mm., a circular slide, and a microscope. A detailed description of the features is given.

The procedure is given in detail of preliminary tests with the Bausch & Lomb instrument, and the results obtained from these tests are discussed.


The method referred to in this article, if these find-ings are confirmed, will greatly facilitate the measur-ing of atmospheric impurity. The usual method of filtering off the impurities and weighing them is a laborious process. If a filter paper with the adherent impurities is placed between a source of light and a photocell, the changes set up in the latter are in direct proportion to the weights of the impurities. (BE)


Describes new hand-operated pump to operate midget impinger dust-sampling apparatus recently developed by Bureau of Mines. Compares results obtained with midget impinger and with regular impinger.


Describes tests to determine efficiencies of large and midget impingers for collecting lead dust; compares results.


The system, installed at the Hiram Walker plant to maintain a minute by minute checkup on smoke conditions, is described.


Gives directions for using the chart and computing the density of smoke.


The bag test is described. This consists in extract- ing a certain volume of gas from the main gas stream and then passing it through one or more bags in which the dust is filtered from the gas, the bags being weighed before and after the test, to determine the amount of dust in the gas.

Although the bag test does not operate at 100 percent efficiency, it is accurate enough for industrial purposes, as virtually all of the dust particles are trapped.


The use of jars, set up in various districts throughout a city, to determine the amount of solids or dust that settles out of the air and their nature, methods of determination of total dustfalls, and analysis of dust deposit are described. Apparatus, reagents, procedure, and calculations of dustfall are discussed.


Methods of gas sampling, apparatus required, procedure, preparation of thimbles, and data required in the determination of the solid material carried by a gas are discussed. Before any actual sampling, it is necessary to deter-mine the average velocity of gas throughout the entire cross section of the flue. It is absolutely essential that the gas be drawn into the nozzle of the thimble holder or sampling tube at the same velocity as the gas in the flue. If drawn too slow the thimble weight will be too high. If drawn too fast the weight will be too low. This is of great importance.


A simple method of analyzing for low concentrations of the combined oxides of sulfur is described. It de-pends on oxidizing all of the sulfur dioxide to sulfur trioxide by hydrogen peroxide, then titrating the total amount of sulfur trioxide (which forms sulfuric acid in the aqueous solution) with a dilute solution of 0.002 N sodium hydroxide. The method is described in de-tail and illustrated.


The impinger apparatus is described. In practice the impinger tube yielded satisfactory results. In tak-ing dust samples, the location of the sampling place, the time that sampling is conducted, and the duration of the sampling are all chosen in an effort to obtain the data required by the study in progress.


Virtually, the same steps are taken in determining dust loading of the air by the thimble method as in
the measurement of dust loading in flue gas. No effort should be made to obtain the wind velocity, as it is impossible to keep the rate of flow into the thimble the same. The only difference is the arrangement of the equipment.


The method devised to measure the effective concentration or activity of atmospheric sulfur dioxide depends on the absorption by a prepared surface of lead peroxide of sulfur dioxide and estimation of the lead sulfate so formed. Its advantages lie in the independence of the rate of absorption on the humidity of the specimen, on subsidiary processes of oxidation, and in the insolubility of the product. The simplicity of the method seems likely to make it particularly serviceable when it is desired to obtain several simultaneous records of pollution, such as may be needed in determining the effect of a concentrated source on the general level of pollution in the neighborhood.

1939


Several methods for reducing atmospheric pollution by chimney fly ash are described and illustrated. Chemical analyses of two types of fly ash are given, also proximate, ultimate, and complete analyses of light ash and heavier ash. In two instances the source of pollution was located by microscopic analysis.

The necessity for a simple scheme for determining fly ash emission that would tie into a practical ordnance is emphasized. Illustration and descriptions of several batch-type and cyclone separators are given. A wet collector and electrostatic precipitator are also described. (JHT)


This differs from its forerunners in that deposit-gage tables giving actual results have been omitted. This makes the present publication smaller and more readable; the full deposit-gage tables for 1937-38 can be obtained as a separate supplementary volume. Tables of mean monthly deposits only are published in this report.

The present report is based on the readings of 123 deposit gages, 16 automatic filters, 58 sulfur apparatus of the two accepted kinds—exclusive of the extra instruments installed for the special intensive observations at Leicester. These instruments are situated at 56 provincial stations and 15 stations in the London area. Compared with the previous year there were fewer deposit gages than last year, the same number of automatic filters, also sulfur apparatus, and three more lead peroxide instruments.

A comparison is made also between records of soot fall in New York City in April 1936 (taken from a paper in the American Journal of Public Health) and London deposit-gage figures for the same month.

An inspection of the New York readings are very much higher than those of London elicited the fact that the New York stations were generally situated much more closely together than those of London and nearer to sources of massive pollution. Results from control stations in New York suburbs agree fairly well with those from the residential and commercial parts of London.

The siting of deposit gages is important in comparing results, and an earlier report has already given particulars of the sites of British stations. An appendix to the present report brings these particulars up to date.

The local study at Leicester is considered to be of first importance. Routine observations for the first complete year have already been taken. It is considered that at least 2 years' complete data must be collected before it is possible to draw useful conclusions from this research. One particular object is to determine the effects of wind and weather upon atmospheric pollution in and around a more or less isolated city.

An illustrated chapter on fog is included. The temperature-inversion effect is described diagrammatically. The causes and structure of fogs are discussed. It is stated that a very slight wind is necessary for the formation of radiation fogs, so common in England, to cool the air by contact with the chilled ground, but at the same time wind is the only agent that prevents the poisoning of the inhabitants of cities by the products of their own fires and furnaces. (BH)


Published investigations of sulfur compounds that are recognized as damaging pollutants of the air are summarized. Sampling methods in both the continuous and the snap type; although there may be many sulfur compounds in the air, most investigators report on the basis of sulfur dioxide.

Methods are briefly reviewed of work done in Chicago, Pittsburgh, Portsmouth, Va., Salt Lake City, Washington, D. C., Philadelphia, St. Louis, Detroit, other United States cities, Panama Canal Zone, and some European cities. Methods of sampling, the types of analysis employed, and the average sulfur dioxide concentration found in the most prominent cities are noted briefly. (26 refs. cited) (CLAC/UCLA)


A method is advanced by the Glycerin Producers' Association for counting dust particles with the aid of glycerin.


Smoke inspectors need some practical method of observing smoke density and recording the observations. The Ringelmann-chart method is widely known and frequently used in the qualitative determination of smoke. Although somewhat inaccurate, it is the most convenient method that has been devised. It probably will continue to be used until a more practical and modern method is discovered. The use of this method is discussed. It is practical, workable, and has stood the test in the courts.


An apparatus is described for the evaluation of CO in air by means of its absorption in the infrared. CO₂ has narrow regions of absorption and emission near 2.7 and 4.4 μ in the infrared. Radiations from a jet of hot CO₂ are passed through an absorbing chamber and are focused on a thermopile. Another method uses a photonic wheel, with a stethoscope as a receiver filled with CO₂ and a thermopile connection. It is claimed that the receiver showed a high degree of selectivity as well as selectivity. (CLAC/UCLA)


This is a report of a survey made by Division "C" of WPA Project 30051 to determine the factors that influence the emission of dust from fuel-burning equipment and the responsibility of this equipment in the pollution of the atmosphere by sulfur fumes. A procedure was formulated from a continuous analysis that would be applicable for the variety of condi-
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Determinations under survey. Determinations were not made of the sulfur content of flue gases, and no conclusions were drawn from the data gathered owing to the great number of variables involved.


A portable apparatus employing the manometric method of analysis and giving high accuracy, with large measuring range, is described. A table of pressure corrections due to changes in temperature during the analysis is given. (CLAC/UCLA)


A panel motor truck, containing sampling apparatus, is used.

Reagents: Distilled H$_2$O$_2$ acidified with Na$_2$O$_2$ and containing 1 cc. 30 percent H$_2$O$_2$ per 2½ liters used as absorbing medium indicator—methylene red containing guinea green dye. Absorbing solution titrated to neutrality with Na$_2$CO$_3$ and after drawing off sample. Volumetric concentration of SO$_2$ determined.

Tests were made in various areas and at several altitudes. Main pollutant seemed to be business and industrial users of fuels. Shelled much high-sulfur coal being used. On foggy days with temperature inversion great concentrations of SO$_2$ were found in most districts.

Low chimneys, domestic or industrial, contributed greatest to the pollution. Most industrial plants using high sulfur coals are potential sources of pollution. Railroads are large pollution factor. Railroad roundhouses present serious problem as high SO$_2$ concentrations prevail in their vicinity every day for several hours.

Washing of stack gases of industrial users recommended as possible remedy or at least partial abatement of the trouble.

Cleaning coal at source much more feasible. St. Louis ordinance requires such cleaning before coal can be shipped into the city for use there. All coal containing more than 12 percent ash and 2 percent sulfur on a dry basis must be so treated. (CLAC/UCLA)


Findings are based on experiments with a new type of magnification eyepiece.


Installing equipment capable of taking continuous samples and recording the results considered important from the standpoint of public health are considered. Although such installations are expensive, they are well worth consideration by firms that have a definite pollution problem, the extent of which they wish to record.

The various types of sampling and recording instruments discussed include those that operate according to the thermal method, the vapor-tension method, colormetric methods, conductivity methods and those dependent upon the absorption of radiant energy. Types and kinds of gases and vapors for which each may be adapted with brief notes on measurable concentrations are included in the paper. (CLAC/UCLA)


The instrument employs the null method in measuring smoke density with a photoelectric cell. Accurate determinations can be made on samples of either low or high density because the length of the effective column of smoke is adjusted so that a constant amount of light reaches the cell. (JIHT)


After considerable use of many types of absorbers the conclusion was reached that two types of absorption bottles were best suited for the sampling of atmospheric contaminants. The first of these is the Drexel wash bottle, with ground-glass connections and with a sintered glass disk, porosity B, fused to the end of the gas entrance tube near the bottom of the bottle. The second type consists of a glass vial fitted with rubber two-hole stopper and an Alexite stone connected to the bottom of the gas-entrance tube. Either type is capable of passing air at 30 liters an hour when connected in series of 2 or 3 absorbers.

Absorbing mediums are dependent upon the gas to be absorbed. It was found necessary to use the all-glass units, type 1, only for those atmospheres that contained gases that would react with the rubber connections employed in type 2.

A few typical types of analysis are included. (CLAC/UCLA)


The essential elements of using smoke index as a research tool are discussed.


Describes methods of measuring air pollution by the bag test. The bag method consists in extracting a certain volume of gas from the main gas stream and then passing this gas through one or more bags in which the dust is filtered from the gas, these bags being weighed before and after the test to determine the exact amount of dust in the gas. (CLAC/UCLA)


A standardized yardstick for the use of the smoke inspector is suggested. It should be a simple standard and need not be terribly scientific or terribly accurate. Smoofall determination, actual dust pollution of the air, and determination of sulfur in the air might be considered helpful in devising a yardstick.


The principle of the Owens jet dust counter was applied in designing the sampling device. Air is sucked through a slit 0.25 mm. wide, 27.5 mm. long, and 3 mm. deep onto the surface of agar or other culture medium contained in a Petri dish placed just below the slit. The Petri dish is slowly rotated during sampling, and the slit is placed radial to the circular surface of the dish, with the inner end 9 mm. from the vertical line through the center of the dish. Hence, the bacteria are deposited in an annular ring, leaving a clear space, about 18 in. in diameter, in the center. The Petri dish can be rotated either by hand or mechanically. The recommended rate of sampling is 1 c. f. m.

The method is very rapid and simple to use, and it has appeared to be more efficient than other methods. The collection efficiency for an aerosol consisting of Staphylococcus albus, sprayed from distilled water as single cocci, is about 96 percent. The method thus
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1437. KATWIJKEN, R. [Determination of Carbon Monoxide With Iodine Pentoxide.] Glückauf, vol. 77, 1941, pp. 22-23. An improvement on the apparatus of Winter and Braukmann is described in which the gas is passed through the iodine pentoxide instead of over it, and an aluminum-block oven is substituted for the oil bath. A tube of NCT; steel is used in place of a quartz combustion tube for holding the copper oxide. (JHIT)


Discusses development and history of Ringelmann smoke chart and describes its use in the United States.


A general discussion includes the causes of intoxication by CO in illuminating gas, the means of preventing it, and the determination of CO in the air and in illuminating gas. (FA)

1440. MOXOM, WALTER J. Observation of Smoke Conditions in the City of St. Louis. Mo. Proc. Smoke Prev. Assoc. America, 35th Ann. Conv., 1941, pp. 98-101. Results are given of the observation and classification of the intensity of smoke accumulations in St. Louis during the heat period from 1906-07 to 1937-38, incl. Only dense smokes were recorded when visibility was restricted to 1,000 feet or less. The average over this entire period was slightly more than 10 dense smokes per season.


The Owens automatic dust recorder is an instrument used for recording suspended impurity in a city at any time. It is not used for the measurement of dust precipitated.

A municipality that operates a Bureau of Smoke Abatement should not fail to have this piece of apparatus. It is an effective means of pointing an accusing finger to specific directions showing smoke locations in the general area. Comparative records over a period of years will indicate if there have been improvements in suspended air pollution.


A 50 ml syringe is provided with a three-way stopcock, by means of which it can be connected with a microabsorber. By manipulating the stopcock, a required volume of air can be passed through a microabsorber until the disappearance or appearance of color in the absorbing solution. The microabsorber can be replaced by reagent paper if required. (CLAC/UCLA)


This is a discussion of the measurement of air pollution at the Central Park Observatory of the Weather Bureau at New York City by an Owens automatic filter, developed in Great Britain. The techniques used by the Weather Bureau in this study are described.


Describes flue-dust sampler, a product of the Atmospheric-Pollution Survey conducted by the WPA in Chicago.
Milk bottles are the heart of this dust-sampling device, which gets even the finest particles of soot. Standardized routine and good instrumentation assure a fair degree of accuracy. The equipment is capable of collecting a 50-grain (about 0.1-oz.) sample in an 8-hour working day. The device collects more than 90 percent of the dust that enters the sampling nozzle.


Describes a unit for sampling air for large impingers, which consists of a case containing a pump, flowmeter, and impinger rack. (JHIT)


In this apparatus, a diagram of which is reproduced, glass beads are used to break up the bubbles of air and release into the broth bacteria that might otherwise escape within the bubbles. Pour plates are made with 1 and 2 cc. samples of the broth. Calibration of the air flow is determined by the displacement of air by water in a 2-liter flask, checking the rates with difference in the manometer levels.

Efficiency tests, carried out by connecting the outlet of one pump to another pump or to a Wells centrifuge, showed the bacteria were thoroughly removed from air samples. Further tests indicated that counts several times higher were obtained with the bubbler pump than with the Wells centrifuge running under identical conditions. (JHIT)

1942


A number of quantitative analytical procedures were investigated. Those seeming most adaptable to analysis for low concentrations and for separation of mixtures were applied to known mixtures. Thus, six methods were selected and appropriate modifications made in them. Those methods selected and presented in the bulletin are: (a) Fuscin-sulfuric acid (Schiff-Elyove) method for formaldehyde, (b) silver precipitation method for total aldehydes, (c) iodometric method for total aldehydes and methyl ketones, (d) sodium hydroxide titration for total organic acid content, (e) analysis for alcohols by oxidation with dichromate in acid solution, and (f) Kjeldahl determination of combined nitrogen.

The bulletin fully describes the various procedures, lists the reagents used in each, and tabulates experimental results obtained from the analysis of known mixtures. (CLAC/UCLA)


Describes recognized methods of measuring various forms of atmospheric pollution, evaluates significance of such measurements, and suggests suitable methods for obtaining comparative information on concentration of contaminants in city air.


Several methods and instruments used for determining the concepnsion of dust in the air are described. The methods are divided into two types. In one, the sample of air containing the dust is projected at high velocity against some medium that will retain the dust; such instruments are collectively called impingers. In the other method, a sample of air is drawn through some device that allows the air to pass but will retain the solid matter; such instruments are called filters or precipitators. Among the instruments described are the Zeiss kistomter, the Greenburg-Smith impinger, paper filters, sugar-tube filters, and the thermal precipitator. (JHIT)


Poisoning by carbon monoxide is to the front, owing to the use of substitute fuels in motor cars and to the introduction of water gas into illuminating gas. Hence arises a call for a delicate means for detecting this poison. Various methods in the dust are reviewed and rejected. Then a method is described in which the graduated photometer of Pulsfrich is used. By this method it is claimed that 1 part of CO in 100,000 parts of air can be detected with certainty. The air to be analyzed must first be freed from all oxygen; this is effected by hydrosulfite of soda; then it is brought into contact with a solution containing a known amount of hemoglobin. It is shaken for 10 to 15 minutes and next centrifuged. The result is then examined with the photometer. Working with known concentrations of CO, a curve has been constructed showing the amount of CO present according to the amount of light transmitted. The method is simple and rapid; it allows for easy detection of concentrations between 1 in 10,000 and 1 in 100. Above 1 in 10,000 up to 1 in 200 it is better not to absorb the oxygen from the sample being analyzed. A concentration of 3 in 10,000 is the limit above which clinical symptoms of poisoning may appear, since in such an atmosphere, after 3 hours, 30 percent of the hemoglobin becomes combined with the carbon monoxide at 30 to 40 percent, symptoms are liable to occur. (BH)


The apparatus, described and illustrated, consists of a settling tower into which the dust is introduced, a dust magazine (charge tube) from which almost instantaneous and complete discharge is obtained by an air blast, and an exposure chamber at the base of the settling tower by which slides or leaves are serially exposed to the dust cloud. Consistent results have been obtained. (APB)


The data obtained in a survey to determine the amount of pollution in air overlying Cleveland and the amounts that might be chargeable directly to products of combustion are given. The WPA assisted in the survey. In the survey beginning in 1927, 10 stations were used. Accurate records were kept, and graphs were made of the deposits for each station in both copper and glass receptacles. The paper discusses mostly the contradictory results obtained with the copper and glass receptacles.


1945


Several toxic gases encountered in industry and ways and means of detecting them are discussed. Also included are notations of maximum allowable concentra-
tions in parts per million. Methods of specific analysis for each of the gases discussed are given as is the physiological effects of each gas. The specific gases discussed in the paper are carbon monoxide, hydrogen sulfide, hydrogen cyanide, sulfur dioxide, nitrogen oxides, ammonia, phosgene, radon, and thoron. The analytical methods recommended are those than can, in most cases. be easily adopted to industry with a minimum of necessary equipment and analytical person nell. (CLAC/UCLA)


A solution of 0.005 N in NaOH and 0.3 N in NaCl is tinted with an appropriate pH indicator. The air to be tested is bubbled through the solution until no further change in color occurs. The pH of the solution is then determined by comparing it with a series of pH color standards, and the CO₂ tension of the air is calculated from this pH value. A correction for temperature is important. (APB)


Concentrations of oxides of nitrogen that may prove harmful to workmen cannot be readily recognized by odor, color, or immediate irritant effects. The max imum concentration for prolonged exposure is about 10 p.p.m. An adequate means of determining the concentration of these toxic oxides in the atmosphere is necessary. To this end several analytical methods have been investigated, and the five most acceptable procedures have been outlined. One, the polarographic method, has been recommended as the most sensitive for this type of determination.

The oxides of nitrogen are collected in a suitable absorbent and are estimated in terms of the nitrate formed by their oxidation. The five most acceptable methods for nitrogen oxides determination in the atmosphere are the phenoldisulfonic acid method, the diphenylamine method, the chloranil reaction, the titration of liberated iodine, and the polarographic method. Procedures for all five of these are outlined, and a detailed description of the apparatus used, methods of sampling, reagents, and procedure is given for the polarographic method.

By this method it is claimed that nitrogen oxides can be determined in a concentric SO₂ as 0.0005 mg per ml of solution and that the average recovery for a given range is from 93 to 110 percent. Both alkaline and acid solutions were used as absorbing media, acid solutions being preferred. Hydrogen peroxide (30 percent) was used as the oxidizing agent and quantities of air tested ranged from 2 to 20 liters. The samples are usually collected in evacuated glass bulbs of appropriate size but may be absorbed directly in 5 to 10 percent NaOH solution at the rate of 200-ml per-minute passage of test air. Sampling for 15 to 30 minutes at this rate should be adequate to cover any concentration likely to be encountered in practice. (CLAC/UCLA)


Aldehydes can be separated by evaporation by blowing hydrogen through the solution. An equation for the velocity of vaporization of the volatile substances was derived and experimentally verified. The equation obtained was used for a separate determination of volatile compounds reduced at the mercury-drop electrode of the same potential. Experiments with acrolein indicated that the polarographic method can be used for the detection and determination of acrolein. Acrolein can be determined in acid (pH 3–4) or weakly alkaline (pH 8) solution. At pH 8, the reduction current of acrolein changes rapidly with change in pH. In the presence of saturated aldehydes acrolein should be determined in acid solutions. The content of CH₃O in the presence of acrolein can be determined by adding dimethyl to the mixture. The deviations of chemical and polarographic determination do not exceed 3 percent. (ClAC/UCLA)


The limits of the negative reduction potentials of peroxide (0.25 to 0.75 v) differ widely from those of the aldehydes (1.55 to 1.8 v). The CH₃O can be determined in a mixture with other aldehydes, and the total content of higher aldehydes can be determined. Gases are drawn from an engine by means of a Kogarko valve at various stages of the cycle, condensed by cooling, dissolved in H₂O, and analyzed chemically and polarographically. H₂O, an organic peroxide of an undefined structure, a substance, with a wave at 1.4 v, of a nonperoxide structure (possibly an unsaturated aldehyde), and saturated aldehydes were detected. (CLAC/UCLA)


An absorption photometer based on the same principle as the Tri-Per Analyzer by V. F. Hanson is described. In this case a different absorption band is utilized, which is sensitive for CS₂ and is not affected appreciably by normal atmospheric constituents. The instrument covers a range of concentrations from 2 to 200 p.p.m. The accuracy is 1 p.p.m., and the time of determination is approximately 1 minute. (21HT)


Making use of a new multiple-part stopcock-type metal valve, an autometer has been constructed that determines the sulfur dioxide (plus sulfur trioxide) and also independently the total volatile sulfur content of the atmosphere. This apparatus is also applicable to volatile chlorine compounds, which can produce hydrochloric acid that is absorbed as readily as sulfur dioxide, and affects the conductivity like sulfuric acid. Exploration into the possibility of oxidizing nitrogen compounds to nitric acid, which could be readily absorbed and determined, was unsuccessful. Several nitrogen-containing compounds tested were either completely destroyed or passed through the apparatus without appreciable effect on the absorbers.

The modification in the equipment resulted in the simultaneous determination of total volatile sulfur compounds and certain chlorine compounds, although no success was attained with nitrogen compounds. (CLAC/UCLA)


It is claimed that none of the soluble filters hitherto used in the sampling of dusts and smokes is suitable for the purpose. The preparation of a soluble tetrachloronaphthalene paper is described. The agent is dissolved in ether and added to alcohol previously saturated with the same agent. The ether is evaporated under reduced pressure, and the alcohol con-

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METHODS OF DETERMINING AIR POLLUTION


The results are given of the collection of sootfall in the city of Detroit. The objective was to determine where and when the actual sootfall was the heaviest. It was suggested that standardized terms should be decided upon and used. Simplified methods of analysis also should be formed and used.


The best of the present laboratory tests for CO poisoning seems to be spectrophotometric detection of carboxyhemoglobin (I) at concentrations above 30 percent of the hemoglobin. Tests by chemical precipitation of protein lack sensitivity and are slow. A new method by direct determination of CO is simple, sensitive, and needs only 1 ml. of blood at 10 percent or higher concentrations of I, or 2 ml. for 5 percent concentration. The sample is shaken with 5 ml. 3 percent HClO4, and tested on Pd indicator paper, with 5 percent NaOAc solution. After 5 minutes on a boiling water bath and standing 5 to 10 minutes, the test paper blackens if I is present. (FA)


Ejection by a stream of compressed air is used instead of that by a vacuum fan. (APB)


The nature of odors and methods of odor measurement are discussed. A new apparatus is described for measuring odors by dilution. The device is portable and does not require flowmeters or other apparatus necessary in continuous slow dilution methods. Methods of odor control are discussed briefly. (JIHT)


An apparatus is described for photographing the paths of particles of 1 inch diameter in suspension in air and subject to the influence of electric and gravitational fields, photophoresis, and Brownian movement. The observation chamber is a thick-walled, transparent cell between electrodes, of which the polarity can be changed, and under exposure to the intense rays of a mercury-vapor lamp. The particles are delivered to the cell in the form of smoke from the combustion of tobacco, turpentine, or a mixture of pulverized diphenylaminochloroarsine and perchlorate of dicyanodiamine. Measurement of the photographs gives the displacements of the particles due to the effects of the fields and the light pressure. On the assumption that the particles are spheres of known density and that the air resistance is given by the formula of Stokes, their diameters, charges, and velocities can be determined from well-known formulas. The diameters and densities of smoke particles can be determined if the air in which they are floating is ionized so that the particles may capture elementary electrical charges and experience additional displacements. Dimensions, densities, velocities, etc., are given for the different kinds of smoke particles mentioned above. (FA)


Correction factors are developed for the normal equations of flow through fluids. They can be applied to the case of the sedimentation of particles in air. (FA)


This is the fourth of a series of four abridged reports of the New York City Air-Pollution Survey conducted by the New York City Department of Health.

1. Impinger counts made during 1936 in New York City showed an average dust concentration of 0.6 million particles per cu. ft. of air.

2. The average obtained by means of the Owens jet dust counter during this same period was 30 million particles per cu. ft. of air, using a data-air oil-immersion optical system.

3. Ninety-five percent of the particles obtained on the Owens jet dust strips were less than 1 micron in size, with a median size of 0.88 micron.

4. Gravimetric analysis of a sample representing 57 impinger samples with an average dust count of 0.6 million particles per cu. ft. of air showed the insoluble solid content to be 0.17 mg. per m.3 of air. (JIHT)


The fact that even small percentages of carbon monoxide continually inhaled cause progressive degeneration of white corpuscles is emphasized. The author holds that designers of motor vehicles should be compelled by legislation to insure that the exhaust from the engine will be free from carbon monoxide. (FA)


The basis of the apparatus is the standard pump employed in the Department of Scientific and Industrial Research (D. S. I. R.) method for detecting noxious gases. The pump has been modified by fitting a brass plate on the headpiece, with a circular hole corresponding in size to the pump orifice. Under this plate passes a strip of filter paper, the plate pressing the paper against a rubber seating surrounding a metal gauze. A roll holder is also fitted on the headpiece, and the paper passes from the holder under the plate down the side of the pump under a cellophane cover to another holder device. The filter paper is 50 cm. long, and, as the orifice is 2 cm. diameter, 20 tests may be done with 1 strip. The sample is usually taken with 300 pump strokes, giving an air volume of approximately 0.3 cu. ft. A spot suitable for light-absorption measurement is normally obtained. The cellophane cover permits "on the spot" visual comparison. (FA)

1472. HEATING AND VENTILATION. More Light on Dust. Vol. 42, 1945, p. 84.

The electron microscope can reveal particles down to 0.0066 micron diameter and can determine the form of
those of 0.024 diameter or larger. It is therefore useful for determining dust, smoke, pollen, etc., in the air. Specimens are collected on a thin collodion film, which is mounted on 200-mesh stainless steel screen. These specimens are effective in studying air-cleaning problems. (FA)

1473. Koval, V. D. [Apparatus for Detection of Impurities in Air.] U. S. S. R. Patent 65,030, 1945. A vessel partly filled with distilled H2O is provided with 2 electrodes placed above the water level that dip into the water. The electrodes are part of a circuit containing a igniting device. When the air is pure, no current flows through the circuit. When the air contains impurities that dissolve in water to form an electrolyte, a current passes through the circuits. (APB)

1474. Langley, W. D. Interpreting Coal Analyses. Smoke Prev. Assoc. America, Man. Instruct. on Proper Firing Methods, 1945, pp. 45-57. An attempt has been made to discuss briefly, in a logical manner, the various analytical determinations in relation to each other, as well as in relation to some of the more common problems of plant operation, as encountered by the purchasing agent and operating engineer. Inasmuch as a complete discussion of all analytical determinations could not be made in a paper of this length, only those characteristics have been considered that are of major importance to the users of coal.

1475. —. Application and Interpretation of Coal Analyses. Proc. Smoke Prev. Assoc. America, Conf. Smoke Abate. and Conserv. Fuels, 1945, pp. 86-92. There is a certain relationship between the quality of coal and smoke ordinances. There is a direct relationship between smoke ordinances, fuel to be burned, and the laboratory. Coal analyses must be dependable. The importance of obtaining a representative sample and keeping the laboratory work accurate is stressed.

As most smoke ordinances cover the emission of toxic gases, sulfur becomes an important item in a proximate analysis. Among the things that a coal analysis must determine are the B. t. u. value, the sulfur content, and the moisture content.

1476. Reinai, E. H., and Johanneses, A. [Stop-Watch Drop Method for Approximate Determination of Carbon Dioxide in Air.] Bodenkunde u. Pflanzenk.- nähr., vol. 36, 1945, pp. 121-130. Prepare an indicator by adding 5 drops of a solution containing 1 percent phenolphthalein and 1 percent bromthymol blue in BaOH to 5 ml. of 0.005 N Ba(OH). When 5 drops of the indicator are placed on paper, which is suspended in air, the CO present slowly reacts with the Ba(OH), and the following 5-color changes result: (1) A radiating dark-blue blot, (2) a violet circle with a dark-green border, (3) the violet circle is surrounded with a light-green border, yellow on the outside, (4) the inner circle gradually becomes pale violet with a blue and yellow border, and (5) every trace of violet disappears, and a blue circle with yellow border remains. The reaction is finished as soon as the last violet tint disappears from the spot. The parts per million of CO2 can be calculated from the time required. Usually 11 to 13 minutes are required out of doors and 4 to 6 minutes in an occupied room. (APB)

1477. Renaud, R., Thomas, R., and Gilbert, R. [Determination of Carbon Monoxide in Atmosphere.] Mem. services chim. état, Paris, vol. 32, 1945, pp. 36-61. To detect CO in air, a spot test is recommended. Dissolve 0.5 gm. of PdCl2 in 5 ml. of concentrated HCl and water to make 1 liter; dissolve 1 gm. of CuSO4.5H2O and 1 gm. NaCl in a little water contained in a 50-ml. Erlenmeyer flask; 1 gm. of copper turnings and 10 ml. of concentrated HCl and keep in the dark; take 2 ml. of the PdCl2 solution and 0.2 ml. of the CuCl2 solution. With this mixture, a spot test can be made on paper or air can be bubbled through the mixture at 100 ml. per minute, and the approximate content of CO determined by the time required to give a distinct blackening. If H2S is present, it must be removed or a black sulfide will form. A more precise method consists in removing CO2 from the air, drying it, and passing it through a tube containing yellow H2O2; this oxidizes the CO to CO2, which is absorbed by bubbling through Ba(OH)2. Eventually, the resulting BaCO3 can be determined volumetrically by titrating with acid in the presence of two indicators, phenolphthalein and methyl orange. The change in color from red to yellow corresponds to the neutralization of the excess Ba(OH)2, and the development of a pink color corresponds to the decomposition of all BaCO3. Besides these procedures, a continuous procedure was tested for determining the concentration of CO in garages, factories, kitchens, etc., which is based on the heat liberated by the oxidation of CO to CO2 by the oxygen of the air in the presence of the catalyzer hopcalite. Two methods were used in which an alarm will ring as soon as the concentration of CO becomes dangerous. (APB)

1478. Seidenberg, J. Z. [Method of Measuring the Concentrations and the Particle Size of Natural Aerosols.] Compt. rend. acad. sci. U. R. S. S., vol. 46, 1945, pp. 227-228. An apparatus has been constructed for measuring the concentration and size of particles in aerosols in the conditions under which they normally exist, namely, in suspension. The method of illumination used, as described, increases the apparatus resolving capacity, which gives it a great advantage over all former models. The working range of the apparatus is very wide, extending from particles subject to the Brownian movement up to particles several microns in diameter. Determinations and calculations when using this newly constructed apparatus take minutes to do instead of hours, as required when working with the Owens apparatus, and can be made by any observer without preliminary experience. The apparatus is portable and can be widely used in expedition work. (FA)

1479. Siegel, Jac., and Feiner, Benjamin. Sootfall Studies for New York City. Part III of Air-Pollution Survey Report. Heat., Pip., Air Cond., vol. 17, 1945, pp. 495-501. In this report of the New York City Air-Pollution Survey, the methods used in obtaining sootfall measurements are discussed and the data obtained are analyzed to show their relationship to primary and secondary sources of pollution and to meteorological conditions. The sootfall was collected in cans at 90 stations throughout the area. The samples were removed monthly and separated into soluble and insoluble fractions. The soluble fraction was analyzed for soluble solids, sulfates, chlorides, ammonia, and ash, while the insoluble was analyzed for ash, carbonaceous material, and tar. The data, converted to tons per square mile, are used to locate the areas of maximum pollution. In a previous report, these areas were shown to bear a close relationship with data obtained in the fuel-type consumption survey. A quantitative relationship is developed for sootfall as a function of distance to the most highly polluted section of the city as a point source. This is possible, because most of the city is on the downwind side of the center of pollution. It is also shown that the total settled matter varies inversely with the temperature and directly with precipitation. (JHT)

The methods in use for measuring dust content of the atmosphere are described: (1) A measured volume of air is drawn through a filter paper, which is weighed before and after; (2) the Owens jet dust counter in which particles are collected on a slide and counted microscopically; (3) sootfall over a period, such as a month, is measured by deposition in a jar of known cross section. The accuracy of the methods is discussed, as well as the significance of the data so obtained. (FA)

1481. SWARTOUT, H. O., and DEUTCH, L. A. The “Smog” Problem. Los Angeles County, Office of Air Pollution Control, 1945, 14 pp.

A nontechnical discussion of the sources of “smog” (smoke and fog) in Los Angeles and of the preventive measures used and desirable. The sources are discussed individually under the classifications: industrial plants; locomotives; diesel truck and automobile and bus exhausts; combustible rubbish. The liability of Los Angeles to experience periods of temperature inversion and the range of mountains to the north are also contributory agents to the problem. Legal aspects of pollution control are discussed and future plans outlined. (FA)


An apparatus suitable for determination of hydrocarbons in the subsoil air consists of two absorption tubes filled with 40 percent alkali and a column filled with solid alkali to remove CO₂ from the gas entering the apparatus, a combustion column with a Pt spiral to convert the hydrocarbons to CO, an absorption tube containing Ba(OH)₂ for the CO₂ resulting from the combustion of the hydrocarbons, standardized HCl solution to back titrate excess Ba(OH)₂, two microburettes, a receptacle, and an aspirator with a Hg seal. A diagram of the apparatus is given. The apparatus can be used also for determinations of noxious vapors and gases (SO₂, H₂S, and CO) in the air of industrial plants. (APB)


The sharp odor that usually accompanies partly burned fuel gases is generally attributed to aldehydes and other hydroxylated HC compounds. Quantitative tests were made for aldehydes, ketones, organic acids, alcohols, and combined N₃. Of these, formaldehyde was the principal constituent. Quantitative data or suitable direct methods for determining these products of incomplete combustion of gas were not found in the literature. Existing methods of analysis were primarily qualitative or suitable only for fairly high concentrations. Those that seemed most adaptable were applied to known mixtures. The following six methods were selected and appropriate modifications were made:

1. Fuchsin-sulfurous acid (Schiff or Schiff-Elevove reagent) method for determination of formaldehyde.
2. Silver precipitation method for total aldehydes.
3. Iodometric method for total aldehydes and ketones.
5. Alcohols by oxidation with dichromate in acid sol.

Results obtained on 10 analyses showed:

<table>
<thead>
<tr>
<th></th>
<th>Maximum, percent</th>
<th>Minimum, percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>0.642</td>
<td>0.0006</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>0.0006</td>
<td>0.0000</td>
</tr>
<tr>
<td>Glyoxal</td>
<td>0.0023</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Total aldehydes attained a maximum, for any 1 test, of 0.0917 percent on butane, 0.01388 percent on natural gas, and 0.00331 percent on coke oven gas.

Combined nitrogen was found in all samples from traces up to 0.00229 percent. Results should not be regarded as exact figures, but rather as an indication of the relative magnitude of those constituents present. (CLAC/UCLA) 1946


Using a chemical method of preparing suspensions of uniformly sized particles, a study has been made of the absorption of light in suspensions as a function of particle size. The results are of interest in connection with the examination of dust by photoelectric sedimentation and indicate a failure of the Lambert-Beer law. (APB)


In the course of investigations on the oxidation of sulfur dioxide in flue gases, it was necessary to develop a method for the estimation of the sulfur trioxide in a system that contained a large excess of the dioxide (50:1). The dioxide may be determined by iodometric titration, but the determination of the trioxide presents difficulties. The method of anemometric titration has been used to determine the trioxide in the mixtures. The gases were absorbed in nitrogen-sodium hydroxide, followed by acidification and removal of sulfur dioxide by a current of nitrogen, with glycerol in the solution to inhibit oxidation of the sulfite. The sulfite solution was then neutralized and titrated anemometrically with lead nitrate solution, using a simple type of polarograph. (FA)


A phototube in an illuminated air duct continuously measures the quantity of light reflected by dust particles passing through the system. Applications include testing and rating the efficiency of air-cleaning devices. (FA)


A certain platinum oxidation catalyst is inhibited by many poisonous gases. Based on this fact, an instrument has been designed to detect the occurrence of poisonous gases, for instance carbon monoxide, hydrocyanic acid, etc. A catalyst-covered wire serves as one of the resistance branches in a Wheatstone bridge, along which a mixture of methyl alcohol and atmospheric air is conducted. Heat developed by oxidation of the alcohol keeps the wire at a temperature of 200°C to 150°C. When the catalyst is poisoned, the reaction ceases, the wire cools, and the bridge is thrown out of equilibrium. A simple portable model is described. (FA)


Work carried out at the Fuel Research Station to correlate the changes of optical density of smoke particles, with the composition of the chimney gases and the efficiency of the combustion process, is described. Heat loss due to incomplete combustion increases at a rapidly accelerating rate as the smoke density increases.

The heat loss due to the suspended matter itself is not negligible, but it is, nevertheless, small compared
with the loss in combustible gases, which are invariably emitted with the visible smoke. Taking into account the sensible heat losses due to the presence of excess air, the tests confirm the generally accepted view that operating efficiency is at maximum when a small amount of light smoke is being made. The danger of exceeding this small amount must, however, be pointed out, as even a small increase leads, not only to atmospheric pollution, but also to decreased thermal efficiency. (FA)

Forty-six specific contaminants are covered, including benzene vapor, carbon monoxide, gasoline vapor, hydrogen sulfide, and sulfur dioxide. (APB)

A general description of methods of measuring soot fall, location of sampling instruments, etc. (FA)

A method suitable for the study of silicate-silica aerosols, using a 4-stage sampler, is described. The technique has special advantages when respiratory effects are being investigated. (FA)

A method is described for the determination of free silica in industrial dusts by means of chemical, petrographic, and X-ray diffraction procedures. Although petrographic or X-ray diffraction examination is desirable for greater accuracy, satisfactory results can generally be obtained by the chemical procedure alone. The method recommended, applicable to a great variety of materials, including atmospheric and settled dusts and mineral residues of tissue, has been checked by analyzing synthetic mixtures of known composition. In this method the sample is treated with hydrochloric acid to remove easily soluble compounds, then with phosphoric acid to break down silicates, and finally with dilute hydrochloric acid to dissolve colloidal silica liberated by the other acids. In the residue the weight of insoluble bases is determined either by evaporation with hydrochloric acid in presence of sulfuric acid or by ignition with selenium. Given the weight of insoluble residue and that of insoluble bases, the percentage of free silica is easily calculated. Modifications of the method to deal with special cases are explained. (APB)

A brief review of methods for estimation of sulfur compounds in industrial air has been presented. A method for the sampling and analysis for onion oil (allyl propyl disulfide) vapor and asxyl mercaptan vapor has been described. The method is applicable to any organic sulfide vapor that lends itself to combustion in the apparatus described. (FA)

The new Petter smokemeter, which measures exhaust smoke from aircraft engines, is described. The equipment consists essentially of a tube, through which exhaust gases are drawn by a centrifugal fan, carrying a light source at one end and a photoelectric cell at the other end. The output of the photoelectric cell is measured by a microammeter, the sensitivity of which can be adjusted by a shunt rheostat. The output of the photocell is to within very close limits linear with the intensity of the light incident upon it, that is, the light transmitted by the microammeter column. Air is assumed to be perfectly transparent and hence the opacity of the smoke column is given by:

\[
\text{Incident light} = A
\]
\[
\text{Light transmitted by column of air} = \frac{A}{S}
\]
\[
\text{Light transmitted by column of smoke} = \frac{L}{S}
\]
where \(A\) is the microammeter reading when air is drawn through the tube and \(S\) is the reading when smoke is drawn through the tube. Density is defined as the common logarithm of opacity. Since the density of a smoke column is proportional to its length if the standard chosen is a column of smoke 100 meters long, smoke density per hectometer equals \(100 \log_{10} \frac{A}{S}\).

Experiments conducted during the development of an earlier instrument showed that the acidic sulfur oxides present in washed flue gas were not readily absorbed by hydrogen peroxide solutions, whereas sulfur dioxide was completely absorbed. These experiments have been extended, and, by the use of a wetted sintered glass disk, complete absorption is effected. Distilled water absorbs sulfur trioxide completely; a trace of sulfur dioxide is absorbed and is removed by scrubbing the solution with acid-free flue gas. Descriptions are given of devices used to insure constancy of flow conditions in the instrument under all conditions of plant load, thus, ensuring that the electrical conductivity of the absorbent is strictly proportional to the sulfur trioxide content of the flue gas. (APB)

The oxidizability of air can be used as a criterion of its purity. The oxidizability of air is defined as the number of milligrams of O2 consumed in the oxidation of KIO3 in H2SO4 solution of all reducing substances in 1 liter of air under standard conditions. An evacuated flask (specially designed for the analysis) is filled with the air sample; the contaminated air is oxidized in the flask by means of KIO3 in concentrated H2SO4. In the absence of reducing agents this mixture does not decompose at 155° (only 0.1 to 0.2 percent is decomposed), but it oxidizes at this temperature nearly all organic substances, except CH4 and some heterocyclic compounds of N; the oxidation proceeds nearly completely to CO2, without the formation of CO. The quantity of O2 consumed is determined by the quantity of I liberated in the presence of reducing agents according to: \(2I^- + I_2 = I_2^+ + 2I^-\). The I is determined colorimetrically by the intensity of the yellow-brown color of its solutions in mixtures with dilute H2SO4 and KIO3. The I reacts with the oxidizing mixture with the formation of the green of LIO2SO4-type compounds. On dilution with water, this compound decomposes rapidly according to: \(5I_2O_5 + 8H_2O = 2I_2 + 4HIO_4 + 5H_2SO_4\). (APB)
METHODS OF DETERMINING AIR POLLUTION

Describes an electronic device for counting particles. The dusty air is drawn past wire at high speed. When a particle hits the wire an electrical impulse is produced in the wire. This impulse is amplified and recorded on a counter. The wire needs to be electrically charged only when the particles are aqueous. For nonconductive particles, the electrical response of the apparatus varies as the square of the particle diameter; this fact is used to determine the particle size. The apparatus, as described, records only sizes of 2.5μ and over, but a more efficient design should reduce this lower limit. (FA)


The data given show a decided lack of uniformity in dust-counting techniques between different laboratories. Further thought should be given to clarification and standardization. Various suggestions are made for the standardization of dust counts. (FA)


Apparatus for separating and analyzing mixtures of light particles having different terminal velocities in air comprises a tower, about 8 inches in diameter and 20 feet high, with a height that depends on the concentration of the particles to be separated. The tower is built of perforated plate, and a fan beneath draws air through it at a rate that keeps the particles in suspension. The effluent, which is a mixture of air and particles, is then passed through a series of filters, each of which is designed to retain particles of different sizes. The lighter particles pass through the last filter and are collected in a transparent container. The heavier particles are retained in each filter, and the process is repeated until all the particles are separated. The apparatus is simple and inexpensive, and it can be used to study a wide variety of particles. (FA)


Among the methods of detecting carbon monoxide described are the blood method, the use of silver salts (which are reduced by the gas), of palladium or gold chloride (which are reduced to the metal), methods of catalytic combustion, and the iodine pentaoxide detector. (FA)


The development of portable and effective air samplers is described. The most desirable air samplers are shown to be those that sample the air continuously. The use of applying d.c. electrostatic voltage has been studied, and an electrostatic bacterial air sampler has been developed. The simplicity and the duplex electrostatic samplers are described and are compared with the radial jet sampler. Some experimental data are presented. (FA)


Claim 1: A reagent for the detection or quantitative determination of carbon monoxide comprising a simple or complex sulfite or palladium, or a mixture containing the palladous and sulfite radicals deposited on a carrier. (FA)


The observation is made that particle-size studies of fibrous dusts yield inaccurate results if the Owens dust collector is used. Slides prepared from evaporation of a drop of aspirated liquid are not wholly satisfactory because of agglomeration of particles. As an alternative procedure, the use of a settling chamber (dust-counting cell) and a No. 1 microscope slide is recommended. The liquid is allowed to evaporate overnight, and the settled dust remaining after the liquid evaporates is used for particle-size determination. (FA)


A colorimetric gel that will detect and estimate less than 1 part of carbon monoxide in 500 million parts of air, a sensitivity more than 100 times greater than that of former chemical indicators, has been announced. It will detect 0.001 percent by volume in less than 1 minute and determine physiologically significant amounts, 0.01 to 0.4 percent, in approximately 1 minute at ground level. It is possible to diagnose carbon monoxide poisoning by analyzing exhaled air instead of taking a blood sample. The indicating material, yellow in color, is a silica gel impregnated with a complex silico-molybdate compound and catalyzed by means of palladium in the form of the sulfite. It turns various shades of green and bluish green on exposure to carbon monoxide. The color response is a function of time of concentration of carbon monoxide. The indicator gel is sealed in a small glass 5 inches long and the diameter of a pencil, with protecting layers of pure silical gel in each end of the tube. To make a test, the ends of the tubes are opened and the tube inserted in an ordinary 2 ounce rubber aspirator bulb equipped with a rate-controlling valve. The air is drawn through the tube by squeezing the bulb once, and any color that develops is compared with a set of standard chips. For aircraft, table giving correction factors for altitude are provided. The tubes may be modified to detect other reducing gases and vapors, including many organic vapors. (APB)


A small, lightweight impinger for sampling dust-laden air is described. Glass construction permits thorough cleaning, and the location of the air outlet minimizes the possibility of drawing out collecting fluids. (FA)


The Wellingborough dust controversy is again referred to in the October numbers of the Urban Public Health Committee. The Committee has been informed that there should be a gradual improvement in the existing conditions. The Committee was advised that the Department of Scientific and Industrial Research had submitted instructions for the use of the deposit gage for routine measurements of atmosphere pollution, and after consideration it was resolved to recommend to the Council that deposit gages be purchased and that the arrangements be made for their siting in the area concerned. (FA)


Summary of the work done in the past several years on the determination of the contents of the atmosphere over London. (USPHS)

When making dust counts with impinger apparatus it should be ascertained that the number of dust particles is the same before and after collection of the sample. Sample volume of air, and samples of moving air should be compared with those of still air to minimize errors. In one measurement with an Owens jet sampler, with 10,000 X magnification, the geometric mean diameter of the dust particles was 0.65 μ, with a deviation of 2.99. The apparatus and measuring methods used are described. (FA)


Methods of determination of dust in air by sedimentation, filtration, washing, adhesion, electric precipitation, thermal precipitation, and optical properties are described briefly, but none is considered to give very exact results, either quantitatively or qualitatively. (FA)


The electrical system of smoke detection, which gives both audible and visual warning of the presence of smoke, is described. Beams of light from a pair of projectors are focused across the area of risk upon two receivers containing photoelectric cells. So long as the rays of light are not interrupted, a “normal” indicator light is displayed on the control panel, but should smoke interrupt either or both of the beams of light, a red light appears on the panel and simultaneously an alarm is sounded. This device has already been adopted for use in aircraft, and would appear to be suitable for such spaces as ships’ holds, shaft tunnels, stores, etc., and such other compartments as cannot be maintained under constant supervision. (FA)


It is important in the Navy’s ship-preservation program to be able to measure small quantities of dehumidified air. The flow meter used must be capable of measuring 1 to 50 c.f.m., be portable, be simple to use and require a minimum of calibration, and have less than 0.1 in. of static pressure drop. The development, construction, and characteristics of such a direct reading air-flow meter are described. Although only its use in the inactive fleet program is discussed, it has applications to many other purposes, such as indicating flow in ventilation ducts, gas pipes, air and gas machinery, through filters, and air cleaners. (FA)


A modification of the cascade impactor is described. It is an efficient sampler for characterization of aerosols of mass median diameter as low as 0.25 μ. It separates 100 discrete size classes, permitting rapid and convenient size characterization of the aerosol. (APB)


A new test used in the RAF is sensitive to CO in air to the extent of 0.01 p.p.m. when working with only 120 ml of sample. The reagent is potassium palladium sulfate impregnated in silica gel; a black stain of palladium metal is obtained. (FA)


A simple countercurrent absorber is described in which practically complete absorption of the water-soluble gases, such as sulfur dioxide, ammonia, and hydrogen chloride, may be obtained with gas-flow rates, ranging from less than 10 to more than 5,000 times the liquid rates. This absorber, when used in conjunction with a conductivity flow cell, of small volume, gives a rapid recording of the concentration from a few parts per billion to several percent. With the lower gas concentrations, the record is a running average, covering 1 to 2 minutes. An alternative absorber containing conductivity electrodes can reduce this time 10 to 15 seconds, but absorption is not complete. A simple method for delivering small volumes of liquid is also described. Equipment embodying this absorber has been applied to the measurement of atmospheric contamination, to the chemical control of a pilot plant making elemental sulfur from sulfur dioxide, and to the rapid measurement of sulfur dioxide in flue gases in the presence of carbon dioxide. (FA)


Description of the colorimetric determination of PbEt₄ using the darkening due to liberated Pb with H₂S and indication of the amount present. (FA)


A smoke-inspection device, with an observation unit containing a casing having an upwardly open light inlet and a horizontally open light outlet, a plural-plane mirror, with central flat inclined reflecting area, and two flat lateral reflecting areas, whereby reflected rays will be visible from a control point in front of the light outlet or from points to the right and left of the central point. (FA)


A method is described for supporting airborne particles upon thin glass, rubber, or asbestos fibers, where they build up in chains and may be examined in the electron microscope. With no supporting membrane, the contrast and resolution are increased in the micrographs. The specimens are particularly useful for stereoscopic studies. A special reference is made to the study of carbon particles mounted in this fashion. The carbons examined are formed by pyrolysis of acetylene and occur naturally in long, thin chains. Pre-reducible particle-size data for the carbons can be secured by measurements made on individual particles at a magnification of 2,000,000. Evidence for the crystalline nature of this carbon is rendered visible in the micrographs. (FA)

1947


Representative vapor samples of benzene and xylene reproduce to ±4 percent may be obtained using three sampling techniques described. These methods yield samples whose concentrations are easily and accurately measured by their ultraviolet absorption. They show an average loss of less than 10 percent due to handling. The measurement of benzene vapor concentration by either of the two flask methods appears to be satisfactory for both field and laboratory work in toxicology if the concentration is sufficiently high. For low concentrations, the impinger method is to be preferred. For xylene, the impinger method is to
be preferred at all concentrations, because appreciable amounts of vapor are adsorbed on the walls of the sampling flasks. The recoveries obtained in the study indicate that such determination may not be made directly on the vapor samples. (FA)


The air flows through a cylindrical measuring orifice with rounded edge, and the pressure drop with and without dust in suspension, the volume of air, and mass of dust delivered are observed. The method of calculating the additional air resistance due to the dust particles from the observations is explained. On entering the orifice the air velocity increases rapidly, but the dust velocity only slowly due to the inertia of the dust particles. By measuring the air resistance, the average size of suspended dust particles can be found. Test results corroborate the mathematical formula. (APB)


A method is described for determining small concentrations (0.2-0.5 percent) of carbon monoxide by absorption in a cuprous sulfatobeta naphthol-sulfuric acid reagent, known commercially as "cosorben." The modifications necessary to adapt a Haldane gas-analysis apparatus for this purpose are illustrated. Experiments with synthetic gaseous mixtures demonstrated an accuracy and precision of better than ±0.5 percent for CO in concentrations of 0.10 percent or more. Unsaturated hydrocarbons and hydrogen interfere with the results to the same extent that they are soluble in the reagent employed. A comparison of the analyses of several samples by this absorption method and two other methods yielded agreement within ±0.05 percent between the various methods used. The absorption method is quite rapid and only requires 20 ml of sample. (FA)


The common instruments are described, classified according to operating principle. In the instruments for determining combustible gases, the heat of combustion of the gases is measured by the potential of a thermopile or by the resistance of a wire filament. The former principle is used in the common carbon monoxide apparatus, but the latter is used for a variety of gases, and the sensitivity can be varied greatly. Ultraviolet absorption is used in determination of many vapors and has the highest sensitivity for mercury. For some other vapors and gases, infrared absorption is utilized in three possible ways: (1) Selective source; (2) selective detector; and (3) negative filters. A turbidimetric method is used for hydrogen sulfide and carbon disulfide, which are burned to sulfur trioxide. The Thomas electric conductivity method for sulfur dioxide and the depolarization apparatus for oxygen are described. The needs for additional instruments are considered briefly. (FA)


The physical factors that govern the sedimentation rate of particles roughly below 100, which fall slower than 10 cm per second, are described. Methods for calculating the velocities of isolated spherical solid particles are summarized, and a table shows the error introduced by assuming Stokes' law under various circumstances. The behavior of liquid drops and air bubbles is described, and an account is given of the corrections needed for fluid viscosities and interfacial tension. The effects of molecular and turbulent diffusion upon sedimentation of particles are discussed. Atmospheric airborne dust is shown to contain particles whose density diminishes with increasing particle size, owing to the loose nature of the larger aggregates. The effect of sedimentation velocity on the sampling of airborne particles is studied. The trajectories of particles that are sucked toward an orifice while they are falling are worked out, and it is shown that the number sampled in a given time is independent of their rate of fall, so that a true sample results. This applies in calm air, if the orifice is small enough, and the inertia of the particles is negligible. (FA)


This is a detailed description of the Ringelmann chart with illustrations. The use of the umbrascopic chart to assist in getting the chart readings is discussed. (APB)


A method is described for the rapid and accurate determination of four aromatic hydrocarbons that may be present in factory air. The method is based on the fact that the absorption spectra of benzene, toluene, and xylene are quite different in the ultraviolet; their coefficients of absorption show striking differences, especially at 2,475 Å, 2,757 Å, and 2,650 Å. These data and the fact that Beer's law applies to mixtures of these 3 hydrocarbons make it possible to establish 3 equations with 3 unknowns that can be solved. The apparatus consists of a hydrogen lamp to provide a continuous spectrum of constant intensity in the ultraviolet, a quartz monochromator, a photodetector, and an electric amplifier. It was found that absolute alcohol cooled to −10° to 10° retains nearly all the benzene contained in air that is passed through the light. From 1 to 21 cm3 of EtOH at −10° forms the best sample for spectrophotometric examination. Results of tests in paint, glue, or printing plants show that in many cases the benzene content may produce intoxication. (APB)


Although the behavior of fine dusts in air or any other fluid and the ease with which they can be separated from an air stream are often expressed in terms of particle diameters in microns, this relationship is based on Stokes' law, which assumes that the particles are spherical and of uniform density. As most industrial dusts are a mixture of particles of irregular shape and varying densities, it is important to consider the effect of all particle characteristics, size, shape, and density upon their behavior in a fluid. It also shows that the terminal velocity of a dust particle is a measurement of the combined effect of all these particle characteristics as they affect its behavior. (FA)


A rain gage, constructed of aluminum, developed for determination of sulfur brought down by rain and snow is described. The requirements for such gages are listed and discussed. (FA)


The Houses of Parliament are being used for scientific investigations by the Department of Scientific and Industrial Research. Instruments for recording the
sulfur dioxide in the air have been set up near the top of the tower of Big Ben and on the Speaker's Green. The main object of the measurements is to compare the sulfur dioxide concentration at ground level with that at a height above the ground. Sulfur dioxide causes decay in building stone, including the magnesite limestone of which the Houses of Parliament are built.


A method has been developed for determining acetylene in air when its concentration is as low as about 1 p. p. m. When calibrated against pure acetylene as a primary standard, agreement with air-acetylene mixtures of known composition is within about 0.1 to 0.5 p. p. m. over the concentration range 1 to 15 p. p. m. The procedure described in this paper differs in several respects from that recently described by McKeen and Eddy, both in the method of measuring the amount of acetylene collected in the condensing coils and because the authors' studies were made using compressed mixtures of acetylene and air. While McKeen and Eddy were concerned with the acetylene content of liquid oxygen. The modifications introduced in the present work were: (a) The use of photoelectric colorimeter for the measurement of color intensity, using as standards a series of carefully made air-acetylene mixtures, which were treated in exactly the same way as the samples of the unknown mixtures; and (b) the agitation of a measured sample of the air-acetylene mixture in a closed container with a standard amount of the cuprous reagent. (APB)


Designed for tests on smoke filters, this instrument could be applied to the measurement of atmospheric dust and smoke contamination. (FA)


Describes the design, construction, and operation of a sensitive photoelectric instrument developed primarily for measuring smoke penetrations through efficient gas-mask filters. It can be calibrated to measure smoke concentrations and is applicable to a wide range of uses in colloid chemistry and photometry. (FA)


Discusses the inadequacies of most of the present atmospheric-pollution measurements. This is especially true of dust or soot deposit and Ringelmann measurements. Also discusses fly ash and miscellaneous condensation nuclei. (APB)


One aspect concerning materials in a state of fine division is the harmful effect of atmospheric and industrial dusts, smoke and grate from both the measurement and formation, using as standards.

The basic principles employed in sizing analyses are reviewed, and brief descriptions are given of the methods in common use, such as sieving, microscopical measurement, elutriation, and sedimentation, including centrifugal separation. The advantages and limitations of the various methods are also discussed. Assessment of fineness on a basis of surface area, without determining size distribution, may suffice for the routine control of the manufacture and use of powdered materials.

Definitions of particle shape and the relationship between particle sizes as determined by various methods of sizing analysis are discussed in detail, as such knowledge is essential for the interpretation of analyses. The application of "re-solution" to the theory of sedimentation is discussed, and an explanation is advanced for the approximate agreement between analyses made by the hydrometer and pipette methods of certain types of smoke or atmospheric systems. It is shown that there would not be agreement between analyses for systems consisting of approximately equally sized particles. The same reasoning is applied to the influence of diffusion on sedimentation analyses made by gravitational and centrifugal settling. Methods of expressing graphically the results of sizing analyses and of calculating mean diameters are also described. The concluding section of the paper discusses the possibilities of standardizing sieving procedure and certain methods of sizing analysis, with the object of assisting the professional analyst or research worker and of improving the correlation between results obtained at different laboratories. (27 refs. cited) (Author's summary)


Atmospheric industrial dust includes a considerable portion, by weight, of particles too large to be significant in silicosis production. The oversized size of dust frequently tends to retain a much larger percentage of free silica than the fine particles of significant size. It is suggested that the free silica content of the smaller fraction provides a more significant measure of the silicosis potentialities of the dust than is afforded by analysis of the total sample. A procedure is described for the collection and separation of airborne dusts to eliminate the oversize particles before analysis. (APB)


The impinger is used so extensively that the merits and special uses of some other instruments are often overlooked. The others, which are described briefly, include the soluble filter, the insoluble filter, the Koniometer (used extensively in South Africa), the Owens jet, the thermal precipitator, and the electrostatic precipitator. (FA)


Street dirt from 6 sites in New York City was collected in 1924, before ethyl gasoline was introduced, and from 5 locations in 1934, after ethyl gasoline was used extensively; these specimens were analyzed for lead. Approximately 50 percent more lead was found in the dirt obtained in 1934, but in one location there was less and in another the same amount. The method of analysis used is described. (APB)


A procedure is outlined for the simultaneous determination of relatively small quantities of lead (3 µg. per ml.) in the presence of large amounts of zinc (300 µg. per ml.) as found in foundry atmospheric samples. This is accomplished by the addition of a "double internal standard," namely, cadmium in aqueous solution. It is necessary to prepare only solution of the test sample, and the Pb/Cd combination is polarized at/near the full sensitivity (1/5) of the instrument in the in the presence of gelatin as a maximum suppressor, using 0.1 N acidic chloride ion base. The Zn/Mn
combination is polarized at 1/10th of the sensitivity used for the lead determination, but in an alkaline 0.1 N chloride ion base. The greatest advantages of a photographic method are realized when both the samples and standards are determined under duplicate controlled conditions and the concentration of the added internal standard is of the same order of magnitude as that of the ion which is to be determined. (FA)


Various opinions have been expressed regarding the importance of such factors as a “diffusing effect” due to small angle scattering in determining the visual range in a cloud. If a reduction of apparent contrast and an influence on brightness level are the only important factors, conditions at the obscuration point should be described by \( P = C B 10^6 g / (B 10^6 g + R) \), where \( B \) denotes the brightness of an object, which has a contrast \( C \) with its background, \( B_c \) and \( D \) represents, respectively, the cloud brightness and optical density in the line of sight, and \( P \) denotes the contrast luminance. Some experiments to this effect have been performed with an ammonia chloride smoke in a chamber 1.8 m. long. The results indicate that the equation is adequate and that factors not taken into consideration in it play a negligible role in total obscuration under laboratory conditions. The experiments were performed at various brightness levels within the 1- to 100-millilambert range. (FA)


As the apparent contrast of a square test object situated behind a smoke layer is decreased in laboratory experiments, a point is reached at which the object is a light patch of unrecognizable shape. On decreasing the apparent contrast a little further, the object becomes completely invisible. A study of the conditions under which the apparent loss of definition occurs was carried on simultaneously with a study of total obscuration. The optical density of smoke required to produce loss of definition was found to be linearly related to the logarithm of the ratio of object to cloud brightness, in close correspondence with the relation found for total obscuration. Over the range of our experiments the minimum optical density of smoke associated with loss of definition was from 12 to 33 percent less than that associated with total obscuration, the magnitude of the difference depending on brightness conditions. Since the phenomenon of loss of definition is observable in the presence of a veiling glare without smoke, it is probably of physiological origin. (FA)


An electrical precipitation method for the analysis of smokes according to particle size has been investigated. A thin stream of smoke particles moving under laminar conditions in a wind tunnel of rectangular cross section is electrically charged in a small region. The charged particles are then precipitated by the uniform field existing between the charged upper plate and the grounded lower plate of the wind tunnel as a long track along the lower plate. The size-frequency distribution of the particles precipitated at various points on the lower plate were determined from measurements on enlargements of electron microscope photographs of samples of the smoke precipitated at various points. The agreement between theory and experiment is fair. Since the phenomenon of the particles precipitated at a given point is rather large. (FA)


The mean particle size of fog from an air atomizer was established from photographs of fog particles deposited on glass plates carrying a thin film of oil. The distribution of drop sizes is given for H₂O fog from an atomizer at air velocities varying from 3 to 18 meters per second, the mean size diminishing with increasing velocity. A logarithmic plot of the mean diameter v. air velocity gave a straight line. The literature is reviewed as to fog particle size and methods of determination. (APB)


The following methods for determining \( O_2 \) in air were tried: (a) \( TiCl_4 \)-methylene-blue TiCl was too light-sensitive. \( \text{(b) "pyridinium-violet (I) method"; } 1:1 \text{dihydrochloric } 4:2\text{-pyridylidrimum bismuthodiphosphate (II) is reduced in aqueous } \text{NH}_4 \text{ to give a brown precipitate, which combines with 1 molecule of (II) to give (I). SiO}_2 \text{ gel or glass is coated with (I) under } \text{H}_2 \text{, and (I) is decomposed by } \text{O}_2 \text{; the preparation is diffi}- \text{cult, and uniform coating and removal of all } \text{O}_2 \text{ from the carrier are impossible. (c) Air is shaken with an aqueous } \text{Na}_2\text{SO}_4 \text{, with methylene blue as indicator; the time taken for complete oxidation of the concentration of } \text{O}_2 \text{ and values are obtained from empirical graphs. The temperature must be closely controlled. (d) "Pentaphenylencypotenadienyl! (7) (deep violet) is oxidised (to pale yellow) by } \text{O}_2 \text{; a known amount is coated on glass lumps and a measured volume of air passed over. CO is determined (down to 0.025 percent) by oxidation over hopcalite, the temperature change being measured by a compensated differential vapour-pressure thermometer (construction not clear). (APB) }


Claim 1: An apparatus for sampling or treating solid or liquid particulate clouds, comprising a plurality of jets, each having a mouth or orifice terminating adjacent to and directed toward a face of a sampling plate or slide, the particulate-laden gas being passed in succession through each of the jets, the mouths or orifices of which are successively of reduced size.


A laboratory method for determining carbon monoxide in air makes use of the reaction: \( CO(gas) + HgO(solid, red) = Hg(gas) + CO_2(gas) \). The gaseous sample is passed through a reaction tube containing granular red mercuric oxide held at a temperature of 175°-200° C. The loss in weight of the reaction tube during the passage of the sample is an exact measure of the quantity of carbon monoxide present and involves a highly advantageous gravimetric factor. The accuracy of the method has been demonstrated through the analysis of three unknowns submitted by the National Bureau of Standards. (FA)


Photocell detecting equipment has been designed by the General Electric Co., Ltd., in conjunction with the Admiralty, primarily for marine use with oil-fired boilers. Its purpose is to give the boiler attendant immediate warning of a smoky condition in the uptake and so make possible maximum efficiency of combustion, with a consequent economy in the consumption of fuel.
oil. The equipment comprises essentially a projector lamp house, reflecting mirrors, photocell amplifier, indicating lamp, and control box. A 12-volt 30-watt lamp provides the light that is projected across the uptake and is reflected by a mirror through a focusing lens on to the cathode of the photocell. The number of motor may be increased according to the size of the uptake. (APR)


A short historical account is given of methods and instruments for measuring atmospheric pollution, and results of tests are discussed. In the section on the properties of smoke, the intensive surveys of smoke and other forms of atmospheric pollution in Leicester are discussed. (FA)


Methods are dealt with involving palladium compounds, particularly the new Ministry of Supply method, which uses silica gel impregnated with the yellow potassium pallo-sulphite, and a similar type developed in America, which uses palladium-molybdenum complexes on silica gel. A description is given of a new double-aspirator testing device, which can conveniently be used with either the palladium paper or the M. of S. tube. (FA)


Desirable features to be embodied in the design of apparatus for detection and measurement of combustible gases and vapors in the atmosphere and work carried out during the development of a portable detector manufactured for the Admiralty, Ministry of War Transport, and the War Office are discussed. Tests carried out to determine the catalytic reaction of combustible vapors upon platinum and palladium filaments are described, and the heat of combustion of a vapor or gas-air mixture is related to the heat given to electrically heated filaments. (FA)


Claim 1: A dust sampler comprises in combination a venturi tube having an inlet and an outlet and a dust-collecting device having an outlet in the throat of the venturi tube, so that the passage of a gas through the venturi from the direction of its inlet is adapted to draw gas through the dust-collecting device.


Discusses the bearing of coal properties on the mechanics of firing and on the behavior of coal in firebeds; reference is made to the importance of size and screen analysis and of size stability when storage is necessary. Application to new and existing coal-using plants is considered. (APB)


A microgravimetric method, accurate to about 2 percent, is described for low concentrations (0.002 to 0.1 percent) of carbon monoxide in air. The gas is drawn over Hopcalite at 135° C, and the carbon dioxide thus formed is absorbed in microabsorption tubes containing Ascarite, the volume being measured with a flowmeter and stopcock. From the weight of carbon dioxide absorbed in the tubes, the percentage of carbon monoxide is calculated. (FA)


This is a report of the cooperative analyses of two samples of carbon monoxide in air. The analyses were made by laboratories engaged in investigations for the military service during the past war, and this work served to bring the results of these laboratories into closer agreement. (APB)


A knowledge of the particle-size distribution in a powder, slurry, or aerosol is of vital interest to the chemical engineer. Without such information, it is difficult to design satisfactory equipment for dedusting, classification, or grinding, or for other chemical engineering processes, and a full knowledge of the particle size of industrial particulate products is invaluable at all stages of chemical manufacture. Thus, reaction times and speeds, crushing and grinding control, cyclone separation efficiencies, filterability, coating powder of paints, atmospheric pollution, and a host of other factors depend on the particle-size distribution of the dusts, powders, and slurries involved. The purpose of the paper is to record some of the experiences in the field of application of standard methods of size analysis for such industrial control and design. The records are concerned chiefly with sizing in the sub-sieve range, for convenience assumed to lie in the range below 53μ. (17 refs. cited) (FA)


A colorimetric method for determining traces of carbon dioxide, using a Lumetron photometric colorimeter, depends on the decrease in color intensity of a solution of sodium hydroxide colored with phenolphthalein indicator. The alkalinity of the solution decreases as it absorbs carbon dioxide from the gas sample to be analyzed, and, consequently, the depth of color decreases. The change in the amount of light, which the solution transmits, is made a measure of carbon dioxide concentration. The precision and sensitivity of the method are functions of the carbon dioxide concentration as well as the volumes of the gas sample and absorbing solution. In general, the precision increases with increase in carbon dioxide concentration being measured, with the use of larger gas samples and, within limits, smaller volumes of absorbing solution. The accuracy of the results is considered to be of the same order as the precision. A 1-liter gas sample is sufficient to determine a carbon dioxide concentration in air of 0.001 percent (10 p.p.m.), with a precision of 10 percent—that is, ±0.0001 percent. (FA)


The basis of measurement is the density of flue gases containing CO2 in relation to the density of air, and the proportion of CO2 in the gases is directly recorded on a chart. The principle of operation is the torque transmission from an impeller to a vane or impulse wheel placed opposite the impeller and housed in a gas-tight chamber. For a given speed of rotation, the torque transmitted to the vane wheel will depend on the density of the gas in the chamber, that is, the percentage of CO2 in the flue gas. Two impeller impulse wheel units are used, the upper chamber being used for air as a standard of density measurement and the lower chamber for the flue gas. The two impellers rotate in opposite directions, and the torque transmitted to the vane or impulse wheels are balanced one against the other by a simple linkage. The position of this linkage depends on the relative value of the torques, so that a pointer connected to the linkage indicates the percentage of CO2 in the gases. (FA)

A methane-filled proportional counter tube and circuit is described, together with a means of attaching a paper filter. This filter is used to collect atmospheric dust and the counter to measure x-activity of the dust. (FA)


Theoretical and experimental investigations show that the distance of visibility in the horizontal plane is determined equally by the simultaneous effects of absorption and scattering, and to a first approximation (attention factor), -1. It was confirmed experimentally on dense mists, that, in the case of aerosols, the nephelometric method yields exaggerated values of visible distance. It is concluded that the nephelometric method of determining transparency of an atmosphere, disregarding degree of light absorption and spatial nonuniformity, cannot be recommended for investigating dense mists, dust atmospheres, and artificial smoke clouds. (APB)


Outlines methods for particle-size analysis, for measuring "terminal velocity," ultimate velocity of falling through a given fluid at rest, elutiation measurements, and graphical representation of dust analyses. Discusses dust problems in fuel handling and burning, action of centrifugal dust collectors, and dust-collection efficiency. Use of the terminal-velocity method is recommended. (FA)

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Using a chemical method of preparing suspensions of uniformly sized particles, the author has studied the absorption and transmission of light by suspensions of varying particle size. The results are of interest in connection with the examination of dust by photoelectric sedimentation and indicate a failure of the Lambert-Beer law. (FA)


Discusses various methods for determining dust in gas. (FA)


Gives reasons why the deposit gage is not trustworthy for measuring atmospheric pollution, and suggests that a revolving apparatus, designed to intercept impurities carried along by winds, whatever their direction, would be more reliable. (FA)


The methods of measuring drop-size distribution in fog and cloud are difficult and tedious. One of the most accurate ways, that of electrical precipitation, is too delicate for everyday use. But it has been employed by the authors as a check on a refined mechanical technique. The simplest mechanical method, that of placing an oil-coated plate in an airstream, selects highly in favor of the large-size droplets. The authors calculate theoretically the capture coefficient (ratio of given-size drops captured to those passed) as a function of airstream speed, plate width, and drop size. Other things being equal, it is shown that the capture coefficient is the higher the narrower the plate, and approaches unity as the width approaches drop dimensions. This fact suggests the use of a network of very fine fibers. Flexiglas fibers were tried and the results found to compare favorably with the electrical methods. Much caution, however, is still required in employing such direct-counting techniques, and indirect means, such as those utilized by the recently considered optical instruments, appear to be more promising. (FA)


Points out benefit of knowing how much solid material settles from the atmosphere. This material can be gaged observing the color of the air, which is not at all reliable, and by dust-count machines, impinging apparatus, setting out strips of adhesive paper, or by setting out jars. The latter method is the best in use, though it is far from satisfactory as the Jars probably record a far greater amount of dust than they should due to weather conditions. In an attempt to standardize methods of dust collection, 84 cities received questionnaires, the answers to which showed a wide variety in type and use of Jars. The author gives several suggestions for those wishing to set up a jar system of collection. (FA)


A new electronically operated smoke-density recorder has been developed, which consists of a Bailey electronic recorder, a binocular-type smoke detector, and a sealed-beam light source. The smoke detector and light source are used as the primary element and are installed on opposite sides of a smoke passage. The amount of radiation reaching the filament in the detector depends on the density of the smoke or dust, and the temperature of the filament depends on the radiation reaching it. This filament temperature is measured by the electronic recorder in terms of smoke density. (FA)


The factors influencing the turbidimetric estimation of sulfur trioxide in the presence of sulfur dioxide have been investigated, and a procedure is recommended for using the method in the analysis of boiler-plant flue gases. (FA)


In a series of experiments a cloud of fine quartz dust of less than 1 micron diameter was produced. The dust particles were variably mixed with aerosols generated from distilled water and eosin, following which the mean diameters of the individual particles increased from 50-100., The results suggest that aerosols may be useful to facilitate and supplement current methods for the more adequate control of dust hazards in various occupations. (FA)


An interesting apparatus has been developed for simple and speedy extraction of dust samples from dust-laden gas from a flue or chimney. It is novel, in that the apparatus itself is first used as a Pitot tube for measuring the gas velocity in the duct from which the sample is to be extracted, and then the rate of flow through the apparatus is matched by making allowance for the frictional loss, which has been deter-
mined for a part of the apparatus. When the apparatus in use at lower is not required. (FA)


General information is given about the organization known as The Investigation of Atmospheric Pollution, in which systematic measurement of air pollution is carried out by local authorities, and coordinated by and under the auspices of the D. S. I. R. through the Fuel Research Station. In addition, there are explanations and diagrams of each of the instruments used and a section on the new rapid surveys. Useful notes are included on the interpretation and presentation of results, the factor of casual error, and similar practical points. (FA)


A method applicable to the electron (or light) microscope is described for distinguishing silicous from nonsilicous particles by treatment of specimens with hydrofluoric acid vapor. A method is described for sampling dusts and fumes directly on nitrocellulose film by electrostatic deposition. (PAPB)


When gas concentrations in working atmospheres are relatively constant, spot sampling of the air is satisfactory. However, when gas concentrations vary widely and rapidly, spot sampling becomes tedious and hard to interpret, and some means of determining average concentrations directly is of considerable value. The device described collects at a constant rate, is simple in construction, adaptable to a variety of conditions of use, and the collection rate is independent of ambient pressure over a very wide range. (FA)


Particles suspended in an air stream moving spirally segregate into (1) those flung to the periphery by centrifugal force, (2) those carried toward the center owing to friction of air to particle. A centrifuge built on this principle is described. Dust-laden air enters between two rotating parallel disks, and the speed of the air stream determines the critical grain size. Design details, errors and their effects are discussed, procedure is described, and some results of analysis are given. (FA)


This review of particle size as a principal factor in determining the magnitude of hazard in dust exposures is presented primarily to emphasize the need for further research. It is emphasized that the actual values employed in the several curves given are not reliable since they are based on insufficient data. (FA)


Tests and measurement of intensity of pollution at ground level are discussed together with evaluation of the tests and control of atmospheric pollution. (FA)


Describes construction and operation of an apparatus for determination of the volume-percentage content of CO in the air, including calibrations. CO is drawn from air by oxidized gases of carbon absorption is oxidized by passage through a layer of hot platinum catalyst (about 3 gm.), and the temperature rise of the air stream (about 60 percent of theoretical) due to the combustion is measured. The apparatus is calibrated against gases of known composition; this collects for heat losses and allows the volume-percentage CO content to be read as a function temperature rise. CO concentrations of 0.01-0.1 volume-percentage can be determined with an accuracy of 0.006-0.01 percent. (FA)


The essential parts of this apparatus are a spongy disk, an elastic membrane, a disk of filter paper, a cover with a small hole flanked by two lintiform protuberances, the whole assembled in the order named in a threaded ring and a flask containing a solution of palladium chloride in a mixture of water and acetone. The cover is the same color as this solution. The tints of the two protuberances correspond to those taken by the solution in contact with an atmosphere containing 0.05 and 0.1 percent CO, respectively. The part of the filter paper opposite the hole in the cover is moistened with the solution of palladium chloride. The apparatus is then exposed to the atmosphere under suspicion. The tint of the filter paper when compared with the colors of the cover and the two protuberances gives a indication of the CO content of the atmosphere. Comparison of the results with those obtained with the Drager instrument is satisfactory. The shape of the two protuberances somewhat hinders comparison of the tints. The possibility of juxtaposition of the colors would have been preferable. The prospectus accompanying the apparatus indicates a CO tolerance a little too high for the worker. The reagent is guaranteed only for 4 months. Aging does not have any visible effect, and the user is advised to renew the reagent periodically. (FA)


To estimate the possible errors introduced by deviations from the spherical particle shape in Stokes’ law estimates of dust particle sizes, a model study was made with objects of various shapes falling in oil of high viscosity. It was found that all shapes fall more slowly than the sphere of the same mass and volume. The influence of particle size is, therefore, less than the estimates calculated from their rate of fall using Stokes’ law. For shapes of extreme dimensions (very thin plates and needles) the error thus introduced exceeded 50 percent. For more common configurations of spheres it was about 20 percent or less. No simple relation between particle surface or any other parameter and the rate of fall could be discovered. All plates and needles turned their planes and longer axes into a horizontal direction when falling freely, unless one side was distinctly weighed. A small asymmetry in weight distribution tilts the planes slightly, causing the model to drift sideways in its fall. In a Hopper and Lady method of particle analysis such a drift makes a particle appear charged, although it may be neutral. It is, therefore, not possible to analyze plate-like and needle-like powder and dust particles by such a method. (FA)


Discusses the problem of measuring solid atmospheric pollution. (FA)


The danger of carbon monoxide poisoning among men working on gasoline-driven vehicles is emphasized. A
concentration of several thousand parts per million may occur in the air near the exhaust outlet, even outdoors, unless exhaust gases are discharged so that the carbon monoxide is diluted before it can return to any area where it may be inhaled. Symptoms, which usually occur when the carboxy-hemoglobin content of the blood reaches 20 percent, include headache, dizziness, faintness, nausea, and vomiting.

Samples of exhaled blood should be analyzed for the presence of carbon monoxide as soon as possible after exposure, to minimize the reoxygcnation of carboxy-hemoglobin, but they can be frozen and sent to a laboratory. The presence of a significant amount of carbon monoxide in the blood will differentiate symptoms due to carbon monoxide poisoning from those due to other causes, especially alcohol. Heavy cigarette smoking may produce carboxy-hemoglobin levels up to 30 percent. (FA)


The condensation nuclei present in ordinary atmospheric air are discussed. Aitken's method of determining their abundance quantitatively in the atmosphere, value of this work, and nature of the nuclei are described. (FA)


Describes a rapid and convenient method for determining hygienically significant concentrations of sulfur dioxide in air based on time required to decolorize an iodine-potassium iodine-starch solution in flask of a conventional midget impinger.


Stereophotometric measurements of the size of dust particles visible under the microscope lead to more accurate determinations, since the systematic errors obtained by determining the size of flat projection are obviated. Mathematical analysis of the mistakes possible in this three-dimensional measurement shows that the magnitude of the error depends on the small dimensions of the base. Linear parallax is negligible. The use of modern optical apparatus makes it possible to measure particles >1–2µ to 0.1µ with less waste in time and energy. (FA)


Describes a micro method for determining the permeability of a 50-mg. bed of dust particles. The results are slightly lower than those obtained by using the turbidimetric method. (FA)


Reasons are given for the need for atmospheric-pollution measurement. Includes a brief description of methods and equipment used. Results show that pollution is heavier in industrial and crowded residential sites. Deposits, smoke, and sulfur dioxide are the chief objects of measurement. (FA)


The advantages are described of a slight modification in the method of determining carbon dioxide described by Gizon and Navarez in 1943, in which the carbon monoxide is fixed as carboxyhemoglobin and measured photometrically. The modification mostly consists in using a larger quantity of hemoglobin so as to determine a larger quantity of carbon monoxide than the original methods called for. (FA)


Investigations were carried out to determine how the transmission of a dust film on a smooth surface varies with time and with the angle of the surface. Measurements were made on nearly 300 samples of glass plate, which were exposed to dust in three locations. An empirical equation relating transmittance to time and angle is given. (FA)


The need for active cooperation of local organs of government, politics, and public opinion and for a simple cheap method of pollution measurement is stressed. Types of community nuisance are considered under the headings carbon and ash, and the control of dust and fly ash as distinct from visible smoke is discussed. (APB)


In the compact, portable detector described, the carbon monoxide contained in a sample of air is caused to react with hypocalite, the heat of the reaction causing a rise in temperature, which is measured with a number of thermocouples connected in series. The device can also be used to give approximate qualitative determinations. (FA)

1949


The use of photoelectric cells gives the most reliable measurement of opacity of the air due to smoke, and electronic equipment is finding increasing use for that and similar purposes. Several modifications for simple reading and for smoke control are described. Among the applications are fire prevention, grain drying, dust leakage, turbidity indication in liquids, and visibility control in tunnels. (IHD)


Method based on the violet color formed by the action of sulfur dioxide on thioureaformaldehyde reagent. (FA)


A sturdy and versatile sampling apparatus for use in determining dust in various hot or cold, wet or dry stack gases, such as open-hearth furnace and boiler-
furnace stack gases, sintering-plant stack gas, and miscellaneous gases producing nuisance dusts.


A mobile instrument of extreme sensitivity has been developed that furnishes a rapid indication and an approximate assay of localized relatively high concentrations of lead, combined or elemental. Sample air is drawn through a conditioned spark discharge adjusted to minimize air lines and to excite the lead spectrum, which is photographed with a small quartz instrument. Visual examination of a series of exposures provides data on lead concentration as a function of time and location. A sensitivity of better than 1 part in 20 million can be maintained in routine operation. Instantaneous response has been realized by substituting the photocell Geiger counter for the photographic plate. (APB)


An approximate method has been developed for estimating the dissemination of aerosol particles from point sources based on the statistical methods proposed by Sutton. It is assumed that concentration profiles above the ground may be expressed as the sum of two profiles, one resulting from diffusion from the source and the other from diffusion from an image of the source below the ground. Sutton's equations are modified to take into account the finite settling velocity of aerosol particles. The rate of deposition is controlled by the concentration adjacent to the ground and by the true settling rate through the stagnant layer. The results are presented in the form of graphs showing the fraction deposited as a function of distance from the source, height of the source, diameter of the particle, and atmospheric conditions. (4 refs. cited) (Authors' abs.)


Claim 2: The method of estimating the dust content of the atmosphere at a particular level, which comprises towing at that level a dust collector of known inlet area and a filtering element of known weight of a fineness that will retain atmospheric dust, in a substantially straight path from an aircraft for a measured distance and then weighing the filtering element to determine the increase in weight per unit volume of air traversed. (FA)


The precision of reproducibility of counts from impinger, midget impinger, a. e. and d. e. precipitator, and probably filter paper samples is such that about two-thirds of such counts obtained under identical conditions should agree within ± 5 percent, about 95 percent within ± 10 percent, and over 99 percent within ± 15 percent. That is, the coefficient of variation of such counts is about 5 percent. The correlation between counts, both light and dark field, from simultaneous samples with few exceptions is good. (APB)


The effect of water sprays in increasing light transmission through a paraffin oil smoke has been studied. Sprays having 50 percent of particles of sizes under 200μ, 620μ, and 2,750μ were used, and in each instance the relationship between rate of consumption of water and increase in light transmission was linear. Under the conditions of the experiment the amount of water required to effect a certain increase in light transmission was proportional to a power of the median drop size (50 percent under) of the spray of about 1.1. The cooling effect of the water sprays in the smoke was greater than that of the coarser, but results of temperature measurements did not permit quantitative interpretation. The effect of about 0.15 percent of a wetting agent in the water used to form the spray was examined. Two cationic agents, Finoxol C and Lissolamine, and one anionic agent, Calsolene oil HS, were examined. Of these, Lissolamine and Calsolene oil had no appreciable effect, but Finoxol C improved the light transmission increase, as compared with water alone, by about 10 percent. As far as could be detected, this was not due to any increase in the fineness of the spray brought about by the wetting agent through a reduction of surface energy of the water. It must therefore be attributed to increased effectiveness of collision between smoke particles and water droplets. (FA)


The effect of smoke on burner efficiency has been investigated. The main lines of research are: (1) To study, analyze, and provide statistical data on the effect of continuous or running smoking on overall combustion efficiency; (2) to determine the effects of highly refractory firebrick and soft insulating firebrick in terms of smoke ratings on the cycle of the burners; (3) to analyze effect of pump-pressure cutoff in terms of the time taken by unit to come down to zero smoke rating. Results showed there was no exact ratio of increase between temperature and smoke rating, but stack losses were proportional to the smoke ratings. It was found that heavy brick-chambered units required over twice as long to attain a balanced combustion condition with a fairly stable CO reading, as those of soft brick. Graphs show that heavy brick will affect the starting smoking conditions, but the evidence is not absolute. A comparison between two burners, one ordinary type and one fitted with a special cutoff valve, showed that the latter came down to zero smoke rating more quickly than the former. (FA)


Proposes use of silver permanganate to detect and remove carbon monoxide from the air. It is alleged to be far more effective than hopecalite. It is more easily stored, has a longer life, and is sensitive at very low concentrations of the toxic gas. (FA)


The midget-impinger method for the collection and analysis of airborne dust has been used to make a dust survey in a small industrial town in Pennsylvania. Although only relative and dependent on a number of factors, the results indicate the method can be used with reasonable satisfaction for locating dust-producing areas. The major advantages offered when used in the method are: An extensive survey can be made in a few hours; the equipment is rugged and easy portable; and it is not necessary to employ highly skilled help in collecting the samples. Limitations of the method are discussed. (FA)


The C. R. C.-Photovolt Smokometer consists of a tube 15" inside diameter with glass windows at each end. A lamp is mounted at one end, and at the other is a photocell connected to a microammeter graduated in percent smoke. A heater is also provided to prevent condensation. A blower and a system of valves enable an exhaust sample to be admitted, to allow scavenging with clean air. The light intensity is adjusted to give full-scale deflection (zero smoke) on the microammeter when the tube is clear. Smoke that will just extinguish the light impinging on the photometer is considered 100 percent, when the meter deflection is zero. The apparatus is designed to operate on either 110-volt, 60-cycle a. c. or 6-volt d. c. Varying exhaust-flow characteristics make the design of the sampling connection at the exhaust pipe of great importance.

For stationary engines two types are recommended:

(1) A small tube located across the exhaust pipe at right angles to its axis with a milled slot or drilled holes on the upstream side. (2) A flash connection pointed upstream at an elbow in the main exhaust line. Satisfactory sampling may be obtained with buses and trucks by insertion of a sampling probe in the tail pipe. Where exhaust gases are pulsating, sampling lines should be designed to dampen the portion of exhaust gases going to the smokometer. Methods for scavenging the sampling line for elimination of condensate are described. At least 20 minutes before operation the lamp and heater are turned on, and they are left on throughout the test. Sampling line and tube are scavenged of residual smoke and condensation. Windows are wiped clean. The microammeter is balanced to zero smoke reading, during which operation the blower is turned off.

The exhaust sample is introduced either on the continuous-flow or batch-sampling plan, the former being almost necessary during acceleration. Under constant speed and load conditions of the engine, the smoke density is given by the stabilized meter reading after initial movement of the microammeter needle. Under changing speed conditions, the peak reading of the meter is taken. Maintenance is dealt with briefly. (APB)


The material presented is from a study by the Research and Development Division of the New Mexico School of Mines under sponsorship of the Office of Naval Research.

An impactor for collecting airborne particles, similar to the Kozn konimeter is described.

The impact method was found suitable for sizes down to about the limit that can be worked with satisfactorily under the optical microscope. Chemical techniques yielding considerable information about the material collected and appearing capable of extension to a wide variety of material are described. Some applications of the techniques to special problems are discussed. (4 refs. cited)


This booklet contains formulas and charts necessary for working out design problems. A nomogram is included to simplify the work necessary for determining certain values normally worked out by formula. An illustrative example is included. (FA)

1605. ELECTRIC POWER PLANT REGISTER. Industrial Smoke Control. 1949, pp. 5-6.

Gives details of the latest Radiosizer industrial smoke indicators installed in most generating stations and industrial boiler houses. (FA)


As the suspicion that disease may be airborne is centuries old, it is not surprising that many scientists have long been concerned with the properties of airborne particulate suspensions. Following the rise of modern bacteriology, the medical significance of dilute aerosols has become clear. And, since many bacteria may be cultured to form particles with nearly uniform size and shape characteristic of a given species, aerosols derived from bacterial suspensions may be profitably studied. Knowledge so gained should extend the understanding of colloidal phenomena and clarify the mechanism of airborne disease.

Quantitative studies surely depend on, first, methods for generating uniform dilute aerosols; second, accurate measurement of their concentration; and, third, with living organisms, on their classification and enumeration by biological methods and further understanding of the physical properties of particulates. Although methods of generation are not completely satisfactory, concentration has been determined by the method of impingement and direct photoelectric count. The latter method is convenient, rapid, and accurate provided particle size somewhat exceeds 0.7μ. Although impingement yields results consistent with the dimensionless group, PVD

•derived by May and Sell, a comprehensive theory must include such factors as particle asymmetry, the physical characteristics of the particulate and collecting surfaces, and the microaerodynamics of the impinger used. Biological enumeration is not only slow, but apparently limited by the efficiency of impingement methods. Simultaneous application of photoelectric and biological methods should help increase understanding of aerosols composed of solid particles. (98 refs. cited) (Authors' abs.)


Claim 1: A device for measuring concentration of duct in a gaseous fluid medium comprising an open top container for dust adhesive coating material, a plate, supporting means adjacent to the open top of the container on which the plate is mounted for rotation about its axis with a portion of the plate passing through the material in the container whereby to receive a dust adhesive coating, conduit means disposed outside of the container and substantially at right angles to the plate for exposing successive portions of the plate to a current of the medium after receiving the dust adhesive coating and as the plate is rotated, illuminating means disposed adjacent to the exposure means at one side of the plate for illuminating the exposed portions thereof, means associated with the illuminating means at the opposite side of the plate for measuring the intensity of light transmitted through the exposed portions, means including a wiper in the container operable subsequent to the measuring means for cleaning the plate, and means for rotating the plate on its axis to bring the exposed portions into juxtaposition with each of the means successively. (FA)

1608. GUCKES, F. T., Jr. Determination of Concentration and Size of Particulate Matter by Light Scattering and Sonic Techniques. Proc. Ist Nat. Air Pollu-
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In cooperation with the city health department the Division of Occupational Hygiene and Sanitary Engineering of the Massachusetts Department of Labor and Industries in 1949 completed a study of sootfall in Hopedale.

Describes apparatus designed by W. Watson & Sons, Ltd. (FA)

B. I. S. R. A. is concerned in the investigation of silicosis in steel foundries. A dust meter is shown that uses the Tyndall beam effect for comparative estimation of the dust concentration in air or gas atmospheres. A 30-watt filament lamp and lens system forms an intense and sharply defined divergent light beam, which is passed axially through a cylindrical glass-walled sampling chamber. A sample of the atmosphere being analyzed is continuously drawn through the sampling chamber by a motor-driven suction fan. The light scattered in a direction approximately normal to the illuminating beam is measured by four photomultiplier cells, which are positioned around the outside of the glass-walled sampling chamber. (FA)

A phototube instrument that produces a signal that increases in pitch and intensity as smoke density exceeds a predetermined level is described. (FA)

Presents method of sampling aerosols that relies on the measurement by chemical analysis of the amount deposited by a cloud on selected surfaces. With such a method, a source of power is not needed; moreover, it is not necessary to prepare the systems for microscopic examination. Wires, cylinders, or slides may be used as collecting surfaces. The theory and the factors influencing accuracy are discussed at length, and numerous results are given. (IHHD)

An analysis of particle number and mass-concentration data for aging ammonium chloride smoke in both still and moving air permits certain deductions concerning the average growth of particles under the experimental conditions used. With still air the average mass per particle increased for at least 5.5 hours, although the rate was smaller in the later stages; with rapidly moving air it increased for a comparatively short initial period and then decreased. The results are quantitatively described by equations involving two loss constants and the coagulation constant, whose values are determined experimentally. (8 refs. cited) (Author's abs.)

The monoxide is oxidized, the resultant dioxide absorbed in an excess of barium hydroxide solution, and excess alkali measured by titration with a standard solution of oxalic acid. Appreciable error may be introduced by the use of phenolphthalein as indicator (color change at pH 7.8-8.0), owing to action of acid on the finely divided barium carbonate suspension. The magnitude of this error is determined by using thymolphthalein (color change at pH 9.0); allowance is made by correction of +0.001 percent. Comparison with the iodine pentoxide and with known values of the National Bureau of Standards showed results accurate to within 0.001 percent. (FA)

The work begun in 1947 by the Stanford Research Institute to determine the impurities in the Los Angeles smoke is described. The objectives were to find out what materials were responsible for the poor visibility and for the eye irritation.

Some of the difficulties encountered were the smallness of the particles—1/50,000 to 1/70,000 of an inch in diameter—and not knowing what to look for in analyzing the atmosphere.

The instruments and methods used for collecting particulate matter from the atmosphere and sampling the atmosphere for gaseous impurities are discussed in detail.

The best evidence obtained indicated that no single material produced the eye irritation but a number of contaminants working together.

These substances are discussed in detail as are those responsible for poor visibility. (6 refs. cited)

A sensitive and specific field test for elementary sulfur aerosol was developed to use in studying of toxic effects of airborne sulfur. Adaptation of Feigl's spot test for elemental sulfur has resulted in a method capable of determining concentration as low as 0.05 p. p. m. of sulfur to within 90 percent accuracy, using 1 cu. ft. of air. The procedure is based upon the formation of the thallous polysulfide by sulfur thallous acetate when treated with hydrogen sulfide in the pores of filter paper. Thallous acetate paper prepared this way may be stored several weeks for field use. Aerosol samples are analyzed by spotting the portion of the paper through which the gas has been passed with a drop
of pyridine, immersing the paper in hydrogen sulfide, washing with acid, and comparing the polysulfide spot with standards. Studies yet unpublished have revealed that the pyridine and crystalline forms of the aerosol causing eye irritation, the threshold values are 0.2 and 8 p. p. m., respectively. (APB)


Claim 1: Measuring apparatus comprising a casing, a horizontal extending conduit therein for sampling air to be analyzed containing removable liquid light-closures at the ends of the conduit, a source of light within the conduit adjacent to one of the closures, a light-sensitive element within the conduit and an air sample therein and adjacent to other closures, a depending conduit communicating with the first-mentioned conduit and upwardly extending exhaust conduit communicating with the first-mentioned conduit adjacent to its other end and having a plurality of offsets, the inlet and outlet conduits communicating with the first-mentioned conduit between the source of light and the light-sensitive element, a heating device positioned below the lower end of the inlet conduit, electrical amplifying apparatus within the casing and responsive to the light-sensitive element and arranged to operate a relay, a source of current controlled by the relay, and electrically operated air-conditioning apparatus for the enclosure operated by the current and controlled by the relay. (FA)


The work of the Fuel Research Station on the measurement and properties of pollution in the atmosphere, and measurement and abatement of pollution from particular types of fires and furnaces with various fuels and methods of firing is discussed. (FA)


A method for rapid determination of a series of harmful gases in air by use of photographic films for liquid standards. (APB)


If H$_2$S is absent, the air sample is aspirated through 0.1 N KOH or NaOH, oxidized by 1 percent $\text{H}_2\text{O}_2$ and HNO$_3$, and treated with Pb(NO$_3$)$_2$ in the presence of EOH, with subsequent colorimetric comparison with a standard scale. If H$_2$S is present, the absorbing solution is 5 percent KClO$_4$. For NO, determination the sample is passed through 8 percent KO solution and the color is developed by diazotization of sulfanilic acid and immediate coupling with 1-naphthylamine in the presence of Na$_2$SO$_3$; color comparison is made with standard set of color samples. (APB)


To obtain the amounts of atmospheric ozone from measurements with Dobson's photoelectric spectrophotometer, allowance has to be made for the extinction of light by scattering owing to, molecules and large particles. Dobson has proposed two slightly different formulas, which lead to appreciably differing values on hazy days. On hazy days in winter the differential haze scattering for long wave lengths is positive, and its magnitude increases with increase in the haziness of the sky, this being similar to conditions in Europe. In the hot season in India, however, this scattering is found to be negative. One possible explanation is theory that with certain sizes of particles of given refractive index the extinction by scattering increases with increase in wave length. An alternative explanation is that Dobson's instrument analyzes not only the transmitted radiation from the sun but also some scattered radiation from the surrounding hazy sky. For calculating the daily values of ozone it is assumed that the particle scattering is nearly neutral. (APB)


Contains data on sulfur dioxide determinations made during the smog. (USFHs)


Important methods of sampling aerosols and effluents from industrial stacks and processes are described and discussed. A table listing and comparing the various devices commonly used for such sampling is included. The need for simple measuring techniques for evaluating atmospheric pollution in a reasonable length of time is stressed. (18 refs. cited)


Measuring colloid particle size by observing scattered light is based primarily on the electromagnetic theory developed by Gustav Mie. The pertinent equations of the Mie theory are given in the paper. The authors made four types of measurements: (1) Observation of the transmitted light as a function of wave length; (2) the intensity of the scattered light at a given wave length; (3) the color of the scattered light; and (4) the polarization of the scattered light at a given wave length. Precise measurements were made on aerosols of uniform droplet size produced by a method described in the authors' paper. Measurements were also made on fogs containing a distribution of sizes. Measurements of the size distribution in nonuniform fogs were made by combining gravity settling methods with the optical methods. (25 refs. cited)


A method has been developed for measuring photographically the extent to which visual range has been reduced by haze. Black objects that are far enough away to be partly obscured are photographed; the photographic densities of the images of the objects and of the adjacent sky, if it can be seen, are measured on the negative. The visual range is calculated from these densities, as are the distance of the object and the contrast of the film. The errors to be expected by the method, if the horizon sky can be used as one object, are less than 10 percent with readily available equipment and can be reduced to 2 percent with increased expense and care. (10 refs. cited) (Author's abs.)


An American instrument for the rapid sampling of dust-laden gases is described. The gas is drawn
through a cyclone dust separator and a filter by a pump. (FA)


Identification of substances and determination of their concentrations in a polluted atmosphere present a difficult analytical problem. A very powerful method of approach is to obtain information by several different types of analytical procedures.

This paper discusses two particular instrumental analytical procedures that show promise of being valuable in atmospheric pollution studies. The first procedure employs a titration reaction for determining continuously a particular contaminant, namely sulfur dioxide. The second procedure uses a mass spectrometer. (4 refs. cited)

1950

1632. AIR POLLUTION DISTRICT, COUNTY OF LOS ANGELES, Test Procedure and Methods in Air-Pollution Control, 1950, 60 pp.

The Los Angeles County Air-Pollution-Control District has developed certain modifications of existing procedures for dust determination that have been very helpful in providing reproducible results. With the thought that these modifications might be helpful to other laboratories interested in air pollution and to assist in standardizing this type of testing, the procedures used are presented. The methods of analyses described have been tested by repeated use in the field and in the laboratory. They have provided information on the extent and nature of the contamination emitted to the atmosphere in Los Angeles County.

Following are some of the procedures discussed:

1. Measuring industrial stacks for dust loading mostly for the purpose of installing dust-collecting equipment.

2. Use of the impinger and a modified impinger is described.

An excellent apparatus determines the smokiness of orchard heaters by measuring the unburned carbon collected on a felt pad.

A modified orchard-heating apparatus is used to test the ordinary small home incinerator.

The Volhard and Mohr methods for determining chlorine are described. Methods used for determining cyanide, fluorene, sulfur dioxide, sulfuric acid, sulfides, acrolein, aldehyde, and formaldehyde are given.

Other subjects discussed are absorbing oil mist and vapors, and the method of air sampling, collecting solids and aerosols in air by electrical precipitation, freeze-out method of air sampling, large volume air filtration, particle size determinations, and dustfall measurements.


Electronic smoke indicators with or without recording devices are described. (APB)


The smoke-density indicators described and illustrated have a range and sensitivity that read fine haze differences in stack gases, indicating small changes in combustion quality. They consist of three parts: (1) Indicator unit with or without a recorder, placed at any convenient place in the boiler room for easy observation, (2) Unit installed on side of stack and breeching in such a way that it directs a beam on (3) photoelectric unit on opposite side of gas stream.

Indicating meters are of two general designs—smoke gage and haze gage. The operating range is in a scale graduated from zero to No. 5 Ringelmann, or from zero to 100 percent smoking dissolved salt condition. Exist when stack haze has a density of about No. 1 Ringelmann. The operating range of chief interest is between zero and No. 2 Ringelmann, which is the range covered by a haze-gage scale.


For several years, the Chemical Engineering Department, through the Department of Engineering Research at North Carolina State College, has been interested in certain problems associated with burning fuel oils in domestic heating units. This work has necessitated an investigation of a number of methods for measuring smoke. Three of these methods have been adopted for laboratory use as a result of this investigation and specific information has been obtained using these three methods simultaneously over a wide range of operating conditions. These results together with the principles involved in these and certain other smoke density procedures are presented. The procedures are of interest to those concerned with other combustion processes as well as oil.


The orifice-variable-area meter described permits measurement of small air flows, such as encountered in air sampling, to be made with portable and with improved accuracy and reliability. Applications of the meter to the electrostatic precipitator and to two types of filter paper collecting devices are described and illustrated. With a given orifice diameter, the instrument is accurate only within narrow limits, such as 0.92 to 1.1 cu. ft per minute, and is especially applicable to air sampling at a fixed rate. (IHD)


This paper discusses some of the microscopic techniques for study of air pollution that have been found to be especially helpful and presents some of the results obtained by the application of these methods.

Techniques involved in the optical and electron microscope were used to identify particles collected from Los Angeles smog. Several well-known methods, such as thermal precipitation, impaction, and settling, were used for sampling. Charged particles were collected on charged microscope slides. The overall composition of the material collected was studied by chemical-microscopic methods. The identity of individual particles was determined by studying the optical properties and by depositing reagents on the particles by means of micropipets controlled by micromanipulator. Tarry materials, oily and aqueous droplets, and crystals, which were mainly ammonium sulfate, were collected from Los Angeles smog. Hexagonal crystals tentatively identified as fluorides were observed occasionally.

Settling techniques were particularly convenient for collecting samples to be studied with the electron microscope. Particles, which appeared to have been original droplets containing dissolved solids, and droplets of a relatively nonvolatile oil were observed with the electron microscope.

The methods described should be applicable to many studies of air pollution. (Authors' summary)

METHODS OF DETERMINING AIR POLLUTION

The methods and equipment used in studies of the nature of solids in the Cincinnati atmosphere are described. Analysis of this material is limited to particulate matter other than pollen and bacteria and does not include the determination of condensation nuclei as such, nor does it include more than a cursory examination of the dust for particle size distribution. As complete analysis as possible has been made, however, to determine the presence of known toxic gases, using methods of proved sensitivity and accuracy.


Attention of the committee was called to an article describing a spectrographic method for the measurement of atmospheric lead levels. It was thought that this might have very important application to the field of industrial hygiene and was suggested for further study. (5 refs. cited.)


The sampling and analysis of air pollutants may cover a range of one to many, existing singly or concurrently. Thus, an air-pollution study could conceivably require all the tools and techniques of the analytical chemist. Only the sampling techniques employed, the methods of instrumentation as applied to this field, and the approach to an analytical study of air pollutants are reviewed.

Owing to confusion in the past in use of the terms smoke, dust, fumes, vapors, and gases, the definitions of the American Standards Association are given. (52 refs. cited.)


The use of the bolometer has eliminated many of the obstacles to the accurate measurement of smoke density. The sealed-beam bolometer gives high efficiency through concentration of radiation and elimination of dirt and dust, and corrosion of the reflector by oxygen or sulfur dioxide. The bolometer circuit employs an a-c. potentiometer that operates on the null-balance system. (HID)


Methods recently developed for measuring concentration and sizes of individual particles in aerial dispersions are described. A photoelectric smoke penrometer and a differential photometer designed to measure very small aerosol concentrations are described and illustrated. With recent improvements in instrument sensitivity, it should now be possible to provide a permanent, reproducible standard aerosol for quantitative comparative purposes. Photoelectric counters for measuring particulate concentrations in plumes of industrial smoke with microscopic methods are described. The actual size of particles has been measured electrostatically, photoelectrically, and by measuring the amplitude of particles vibration in a sonic field. These methods are outlined. Measurements of particle size distribution have been made by several experimental arrangements; some of the more promising ones are discussed briefly.


It is known that the mass spectrometer can determine low concentrations of one gas in the presence of large amounts of another, as in the analysis of atmospheres in annealing furnaces for traces of oxygen, or of soil gases for hydrocarbons, but the instrument has not been found suitable for concentrating and determining contaminants in air in the range below 100 p. p. m. The procedure, as outlined in this article, gives useful results when substances that can be trapped by liquid nitrogen are to be determined. This would appear to include most of the ordinary atmospheric contaminants with the exception of carbon monoxide. Typical results are given for several mixtures of solvent vapors in air, sampled in a small test room. The inherent advantages of the mass spectrometric method of gas analysis are rapidity and freedom from interference by chemically related substances. In addition, the spectrum provides a complete qualitative record, which should be particularly important when the source of atmospheric contamination is not completely known. Two recent discussions of mass spectrometry outline the principles and techniques of this instrumental record of analysis.


The detection and measurement of dangerous gases in the atmosphere can be effected speedily and accurately by an electronic device based on the phenomenon of the absorption of a given wave length of the visible spectrum by the mixture of gas and air. The device consists of (1) a small mercury-vapor lamp, a, which projects a beam of light through a cell, b, containing the gas-air mixture in question, and (2) two photoelectric cells c and d set in a bridge circuit. Cell c is excited by the light traversing the mixture to be measured, and cell d by the direct light of the mercury-vapor lamp. The device also has an amplifying wave, e, and a milliampere meter connected in the plate circuit of the valve.

The measurements are made as follows: Cell b is first filled with pure air obtained by suction of the atmosphere through a filter. The circuit of the photoelectric cells is then balanced with a potentiometer, g. The balance is indicated by the milliampere, and cell b is then filled with the mixture of gas; the mixture absorbs part of the luminous energy falling on the photoelectric cell, c, thus throwing the circuit out of balance. Measurement is effected by restoring the balance of the circuit by a graduated screw, f, which descends into cell b and intercepts an amount of light proportional to the length of the portion of the screw in the cell. The device is of course sensitive only to gases with absorption bands corresponding to the wave length of the light emitted by the mercury-vapor lamp.


A measured volume of air is drawn through a pad of granular naphthalene. The dust, quantitatively retained in the naphthalene, is recovered by heating the pad just below the melting point of naphthalene, thus removing the base by volatilization. This temperature is maintained by refluxing a liquid of suitable boiling point (ethyl acetate) in the apparatus. (AIP)


A modern laboratory on wheels is now used in West Virginia cities to facilitate collection and analysis of air samples in studying air-pollution problems. It is equipped with a gasoline-driven electric generator to operate the apparatus, impingers, gas- and fume-absorption trains, toxic gas analyzer, carbon monoxide
Indicator, Orsat gas-analysis equipment, vacuum-filter-type collector, and electrostatic precipitator. The truck is also equipped with a table sink, fluorescent lights, and power outlets so that agents can be prepared for sampling, and laboratory analyses can be performed on the spot. The unit will greatly facilitate the study of air pollution in West Virginia, getting samples in hitherto inaccessible locations and greatly increasing the range of operation. (IHD)


The Air-Pollution Division of the Pennsylvania Bureau of Industrial Hygiene is now equipped with a Thomas autometer, which has been manufactured especially for the bureau by a leading maker of scientific apparatus. The instrument has been made in portable form and is for the purpose of measuring the concentration of sulfur dioxide in the atmosphere. Equipped with a recording apparatus, concentrations of sulfur dioxide of from 0 to 5 p. p. m. may be determined.

Sulfur dioxide has long been known to be one of the most irritant gases polluting the atmosphere of industrial communities. This new equipment will materially assist in the Air-Pollution Division in conducting long-range studies in a community with a view toward determining the magnitude of the sulfur dioxide content of the atmosphere. The equipment will also be available for on-the-spot recordings of sulfur dioxide concentrations in localities where conditions favor the build-up of atmospheric pollution. It is hoped that the data thus obtained may serve as a means of comparing the sulfur dioxide content of the air of urban gases with that of rural areas and to indicate conclusively the magnitude of the sulfur dioxide problem in larger cities in the State.


A method is described for the rapid determination of quartz with an X-ray Geiger-counter spectrometer. Comparison of maxima of diffraction intensity contours traced by a potentiometer recorder for unknown samples and prepared standards affords an acceptable degree of accuracy and speed. Instrumentation techniques, use of internal standards, and effects of binder materials and particle size are discussed carefully. Reported data indicate ±10 percent accuracy for samples containing 3 to 100 percent quartz. (IHom)


Training personnel in the science of reading smoke opacities, without reference to the Ringelmann chart, is an important part of any smoke-abatement program. Obviously it is impractical to use the official Ringelmann chart in an automobile following a smoking diesel truck traveling the highways at 40 or 50 miles per hour, or to determine the opacity of contaminants being discharged into the atmosphere other than black smoke.

The "smoke school" conducted by the Los Angeles County Air-Pollution-Control District, in cooperation with the county civil service commission for training inspectors and engineers is described.

The certificates granted on completion of the course have been recognized, the inspectors qualified as experts, and their testimony as such accepted by the courts.


Dusts and fumes are defined according to the standards established by the Los Angeles County Air-Pollution-Control Division. Maximum amounts of certain contaminants into the outside atmosphere.

Methods of analysis, which include some modifications of existing standards for dust determination, and apparatus used by the Air-Pollution-Control Laboratory are described. The methods of analysis presented have been tested repeatedly in the field and in the laboratory and found helpful in the studies on the contamination and pollution of the atmosphere. The paper is followed by discussion.


During the study of air contaminants it became necessary to determine the amount of free sulfuric acid in the atmosphere. The purpose was to determine the absolute amounts of aerosol at various times of the day in connection with the observed variation in visibility, and to establish the rate of oxidation of sulfur dioxide into sulfuric acid mist under the meteorological conditions prevailing. Specific measurements also were needed to determine the harmful effect of sulfuric acid on animal tissues as well as deleterious effects on vegetation.

As none of the various methods were suitable for their suitability and the determination of very small concentrations of sulfuric acid was rapid enough for their purpose, the authors developed a modified sampling method, which is based upon the use of specially prepared Whatman No. 4 filter papers. Owing to the low resistance and the high collecting efficiency of these filter papers, sampling rates as high as 60 cu. ft. per hour can be used. Inasmuch as a 40-cu.-ft. sample was found sufficient to determine the free sulfuric acid present, this method permits the measurements of hourly variations of the sulfuric acid aerosol in the atmosphere.

The results obtained by this method indicate that the sulfuric acid content of the atmosphere ranges from 0.0 to 0.036 p. p. m., by volume. The highest readings for sulfuric acid were obtained on days that began with a high relative humidity. A high moisture saturation of the atmosphere, when water droplets are condensed on the surface of dust particles, salt spray, metallic oxides, etc., appears to provide a highly satisfactory medium for the sulfur dioxide of the atmosphere to be dissolved and then rapidly oxidized to sulfuric acid. After the temperature increases during the day and the fog particles disperse, the sulfuric acid mist remains in the atmosphere because of its low vapor pressure. In dry air the oxidation of sulfur dioxide of sulfuric acid seems to proceed at a very slow rate. Even in the presence of relatively high sulfur dioxide concentrations, the sulfuric acid content remained very low or immeasurable at a low relative humidity. (9 refs. cited)


The accurate measurement of impurities in an atmosphere is fundamental to any intelligent corrective measures that may be taken to eliminate the pollution. Some of the methods of determination that have been found to be effective in the investigation of smog in Los Angeles are described.

The collection and analysis of particulate matter and gaseous atmospheric impurities are discussed. The use of the proper scattering techniques as a new and useful tool in the analysis of minute samples is described briefly, as well as the direct photographic techniques for estimating the properties of particulate matter in the open atmosphere. Some of the more common applications of these are mentioned, and a few
of the unsolved problems in the instrumentation and measurement are outlined. (9 refs. cited) (Author’s summary)


A portable device for sampling air contaminants permits the scrubbing of large volumes of liquid. This facilitates chemical analysis of the collected materials by making it possible to obtain relatively high concentrations of contaminants in the scrubbing liquid. The action of this portable field unit is based on the principle used in the Venturi scrubbers employed to remove fumes from industrial stack gases. Its efficiency for the collection of several gaseous and particulate air pollutants is discussed. These pollutants include ammonia, sulfur dioxide, sulfurous acid, and sodium chloride.


The results of a 2-year study of air contaminants and techniques for microsampling, as reported by the Los Angeles Air-Pollution-Control District, are discussed.

The report is devoted, for the most part, to chemical research into the little understood causes of eye irritation, crop damage, and visibility, as well as to the techniques developed for microsampling. (6 refs. cited)


Interest shown by governmental and industrial groups in the United States in air-pollution abatement is discussed. Some details are given of the recording condensation nuclei meter developed by General Electric Research Laboratory. (APB)


The Pennsylvania Department of Health has secured an air-pollution and industrial-hygiene laboratory, which will be placed in service by the Bureau of Industrial Hygiene. The mobile unit is equipped with more than 25 scientific devices for field sampling and quantitative and qualitative analyses of atmosphere in industrial communities and factories. The mobile laboratory will be under the supervision of the State's new Air-Pollution Division, Pittsburgh Laboratory.


The author shows tentative standards of the German Engineering Institute for size determinations, chemical analysis, and color adsorption of dusts and gives graphical symbols for their identification. (IHD)


At its Waterside electric generating station (39th Street and 1st Avenue) in New York, Consolidated Edison is experimenting with a television camera focused on one of the tall smokestacks from the roof of an adjoining building. The image of the stack is reproduced on a screen in the boiler control room. This control room is near street level, some 450 feet below the top of the stack. The camera keeps the operator in constant touch with the appearance of the stack and makes it possible for him to note immediately any abnormal condition that results in smoke. For most of the time it is unnecessary for an observer to inform the operator, a time-consuming operation.

Consolidated Edison is testing various television components in its field installation, and has not decided whether to make the installation permanent. All the company will say is that the idea "holds promise."

In recent years, the New York utility has spent more than $16,500,000 in equipping its generating stations with the most up-to-date smoke-elimination apparatus.


A spectrographic method of determining beryllium in air dust collected on filter papers has been developed. The procedure may be used with all types of filters, including pleated gas-mask filters, lower range about 135 mg. of ash, with the range covered from 0.0009 to 10 μg of beryllium on the electrode, and aliquots of one twentieth of the total sample were used.

The filter paper is wet on dry ashed, treated with hydrochloric acid, and the beryllium is precipitated as hydroxide, 2.5 mg. of aluminum being used as carrier. The hydroxide is dissolved in sulfuric acid, and the volume brought to 1 cc. of 1 to 3 acid. Aliquots of this solution are used for the spectrographic analysis. A 0.05 cc. portion is transferred to each of three cupped, waterproofed carbon electrodes containing about 45 mg. of sodium chloride as spectrographic buffer and carrier. Excitation is with the d. c. arc at 10 anp. for 2 minutes, and the spectrum is recorded on Eastman 35 plates with a Baird 3 M. spectrograph. The average of triplicate density ratios of Be 2348/Al 2367 or Be 2650/Al 2367 are used as the analytic curve function. Check analyses show a relative error of +1 percent, except at the extreme.

The advantages of the method over those previously published are: A more uniform matrix regardless of the type of filter; the large useful range; the use of triplicates with the possibility of diluting the remainder of the solution to obtain freedom from background on the plate; and satisfactory sensitivity, even with a slow spectrograph.


Two circuits for electronic smoke-haze-density indicators are given, and the general operation of electronic smoke-density indicators is discussed. (APB)


The various methods and instruments for quantitative measurement of visible smoke and solids discharged from individual sources are discussed separately, as follows: (1) Visible smoke from combustion processes; (2) fly ash from combustion processes; (3) other dusts. In addition to the methods described here the following were discussed in the instrument panel of the United States Technical Conference on Air Pollution in Washington, May 3–5: Sonic and ultrasonic methods, thermal precipitation, direct photography, diffraction and diffusion, and cascade impaction.

Following are authors' summaries and conclusions: (1) There are several accepted methods for determining visual density of stack emissions, although there is controversy as to the validity of such measurements. (2) No single accepted standard method for determining quantitatively the emission of fly ash from stacks exists. There are several accepted methods, but results using them have not been compared authoritatively. (3) There are no standard methods for determining quantitatively the emission of particulate materials other than fly ash from stacks and vents. The several methods used for the many special situations have not been compared in an authoritative manner.
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(4) Because of the lack of standard methods of quantitative determinations of particulate emissions, it is necessary for responsible officials of government to use judgment in selecting the appropriate methods.

5. The standards of emissions should be more closely related to the air-pollution effect of emissions, and such standards of emission should be directly related to standard methods of quantitative determinations of such emissions.


Much of the literature developed in connection with the study of air contaminants in working environments contains information directly applicable to the problems encountered in air sampling for atmospheric pollution. As the chemical and physical information sought is nearly identical in both, the differences are largely a matter of degree.

The type of information to be sought in sampling in atmospheric-pollution studies is discussed, and various basic sampling methods are described. Reference is made to research in and development of new sampling methods and instruments that are being stimulated by the growing interest in atmospheric pollution studies. Research in this field should be devoted largely to methods that are rapid, direct reading if possible, and accurate and uniform in appearance. (5 refs. cited)


The current status of the forecasting program developed for nuclear reactor operations at Brookhaven National Laboratory is discussed in some detail. In examining the forecasting method emphasis is placed on the use of relationships between synoptic and micrometeorological variables as they have been determined by observation and climatological studies. The practical application of this type of method to industrial problems, both in the field of atomic energy and otherwise is considered.


Part I of this paper reviewed the health hazards caused by airborne particles, with primary emphasis on those chemically toxic materials used in atomic-energy production. Here attention is directed to methods and instruments of recent origin that are especially suited to solve these problems. Included are (1) the filter-paper dust sampler and the electrostatic precipitator for quantitative estimation of particulate concentration, (2) the "Modified Cascade Impactor" and the oscillating thermal precipitator for characterization of particle-size distribution, (3) surface-coating techniques and the electron microscope as improved methods for characterization of particulates, and (5) low-temperature ethane adsorption for the measurement of surface area. (36 refs. cited) (PHIA)

1951


The optical smoke comparator, a new color-intensity-measuring device, was demonstrated. This comparator incorporates four shades of smoke within a circle, which has an opening in the center for viewing the smoke, comparing its density with a shade scale.


Reference is made to the Guamer mechanism, a new unit-volume device to measure the density of smoke as it leaves the stack. When an undesired concentration is reached, an air jet goes into operation over the fire bed blasting the smoke and ash particles out of the chimney exhaust and returning them to the firebox for complete burning. Tests indicate that fly ash is reduced to such an extent as 95 percent.


Discussion of problems and of dust-measuring instruments indicates the suitability of Owens jet dust counter in which dust particles are precipitated by the coagulation of water. Photomicrographs and photographs. (APB)


A new technical committee, which is to concentrate its work on formulation of methods of atmospheric sampling and analysis, selection of acceptable nomenclature and definitions, and stimulation of research to accomplish the foregoing purposes held its organization meeting at the headquarters of the American Society for Testing Materials in January.

A number of situations have focused attention in recent years on the seriousness of atmospheric pollution and the necessity of considering what remedial measures might be taken. Great amounts of money have been spent by industry to control various problems. And yet underlying all of the discussions, whether from the standpoint of reducing air pollution or studying atmospheric conditions, there has been a basic need for acceptable terminology and also the development and acceptance of adequate methods of sampling and analysis. Many problems are involved, but with the realization that the society, through its time-tested procedure of bringing together various technical viewpoints on intricate problems, might aid in achieving constructive results, the board decided to proceed. The committee will not be concerned with fixing permissible limits or with enforcement problems.


A small electrically heated filament will be a useful tool for determining information on the number and size distribution of particles in water clouds and other vaporizable aerosols. Although investigations are not yet complete, the detector has already been useful for counting particles and giving a semiquantitative estimate of their sized weighted distribution. The detector measures the ion current produced when a small vaporizable particle collides with a heated filament, which is usually platinum. When aerosol particles collide with the filament, the filament's electrical resistance is momentarily reduced and current flowing through it is briefly increased. The increase in current flow is transformed into a voltage pulse by a circuit containing a transformer, which is coupled to an oscilloscope.

Results indicate that the amplitude of the voltage pulse varies as the mass of the drop from small drops in the range of 2 to 5 μ in radius, and for drops larger than 10 μ, the amplitude of the pulse increases more slowly with drop size. For drops larger than 20 μ radius, the pulse produced has a fairly complicated shape and there are indications that under some conditions the drops bounce off the hot wire. The detector has been used for measuring the concentration of ice crystals in supercooled clouds, and discussion indicated that the new device could have far-reaching importance and use.


The absorptiometric method for determining germinable spores in beer has been adapted for the analysis of flue dusts. The high sensitivity of the absorptiometric procedure permits use of samples
METHODS OF DETERMINING AIR POLLUTION

weighing 0.1 gram or less and this greatly facilitates the decomposition of the sample by sodium carbonate fusion. Duplicate determinations can be completed in 3 to 3½ hours.

The absorptiometric procedure has also been applied to determining germanium in coal and coke. In one method the sample is decomposed by a procedure similar to the Eschka method for determining sulfur in coal. In a second method the sample is decomposed by combustion in a bomb calorimeter. Samples of coal and coke examined by these methods were found to contain 7 to 12 parts of germanium per million. (P1192)


The objective of an analytical procedure in air-pollution studies is to obtain information that can be useful in evaluating a defined problem. This can be attained only when the overall sampling-analytical setup permits the assignment of figures of significance. It is evident then that the following requirements must be satisfied: (1) Collecting efficiency of the sampling equipment must be known; (2) sampling equipment must be selected to produce a minimum alteration in the composition of the substance to receive critical study; (3) equipment and reagents must produce “blanks” smaller than the amount of material collected in the lowest reported concentration; (4) an adequate amount of material, in a form suitable for analysis, must be collected; and (5) measuring procedures must be of satisfactory reliability and sensitivity.

The aim is to show the application of these procedures in the field of air-contamination analysis rather than to duplicate the theory and techniques that have already been so well presented in the literature. (145 refs. cited)


After long consideration the Pittsburgh Bureau of Smoke Prevention adopted the method of using cans for catching dust, which seemed to be the easiest for continuous recording of the pollutant: in the air over the city.

Conclusions reached indicate that the correction of smoke is a small part of the problem of clearing the atmosphere and that the purely mechanical phase of smoke prevention is changing into chemical and other fields.

The improvement in combustion in 1948 over that in 1938 is attributed to the fine cooperation by the citizens and industries of Pittsburgh.


Describes new process by which distribution (by size) of dust particles in dust-laden atmosphere is, for first time, determined directly from air itself. Rate of time is determined directly from air itself. Rate of precipitation of dust particles in close air space was determined by photoelectric measurement of diffusion of light occurring when light is allowed to penetrate dust-laden air. Method can be used to determine percentage of dust removed by dust-removing apparatus. (APB)

1674. HEATING, PIPING, AND AIR CONDITIONING. Smoke Indicator and Recorder. Vol. 23, 1951, p. 84.

An interesting application of the potentiometer is found in the smoke indicator and recorder of the type shown. Two streams of flue gas, taken from different points of the stack, are merged and a beam of light is passed through the mixture. The light source is a voltage-controlled bulb. The light that penetrates the gas mixture falls upon a thermople or series of thermocouples. The energy of the incident light varies inversely to the concentration of smoke. The lens of the thermople concentrates the rays upon the thermocouples, and an electromotive force is generated. The potentiometer measures the e.m.f., and is thus essentially a pyrometer, using a multiplicity of thermocouples. In addition to indicating the smoke intensity and recording the values on a chart, the system can also include warning signals located at any desired places in the plant.


Presents need for development of automatic instruments to determine the relationship between air-pollution intensities and the rate at which they are dissipated by horizontal and vertical winds. The various methods suggested are described and illustrated. (4 refs. cited)


The impinger is a device in which a sample is drawn through a jet to impinge on a glass surface under water. The dust is retained as a suspension in the water from which it can be separated by filtration and weighed, or a volume of the suspension is allowed to settle out on a special type of microscope slide and the dust particles are counted. Its efficiency increases with the sampling velocity, which is normally about 28.1 per minute. Its efficiency is said to be about 40 percent. In the cascade impactor, the sample is collected by forcing air through a narrow jet to impinge on a glass slide coated with adhesive, but the air must pass consecutively through four jets each of smaller size than the last. Finer particles are not retained by the earlier coated slides, resulting in a size grading. Arrangement and size and shape of the jets are described. The flow of air is about 20.1 per minute. (CA)


The Thomas autometer, an automatic sulfur dioxide recorder, is described. Electrolytic conductivity is used to measure SO₂ absorption.

This instrument is not specific for SO₂ because any substance in the atmosphere that will dissolve in the absorbing solution and increase its conductivity will be recorded as SO₂. Such substances include: (1) Oxides of nitrogen; (2) soluble salts, such as sodium chloride; and (3) acid gases or mists. (4 refs. cited)


Describes the methods and procedures used to determine sulfur dioxide, fluorides, and dusts.

The methods discussed are: For sulfur dioxide, an iodometric back titration with sodium thiosulfate; for fluorides, a perchloric acid-water distillation of the sample followed by a thoriun-alizarin lake-fluoride back titration; and for dusts, filtration and cyclonic precipitation, using a Bacharach dust filter and an Aerotec dust sampler. (7 refs. cited)


The development of the photoelectric cell made it possible to dispense with human judgment and to design an instrument to indicate accurately and record smoke emission independently of the weather and lighting conditions and to sound an alarm if the smoke density exceeds a chosen value.
Details of such a device are given with method of application to measurement of smoke. Its indications are a guide to efficient combustion. It is equally reliable with any smoke-producing fuel. The equipment is employed to measure the exhaust smoke from diesel engines and has been applied to measure lead- and tin-smelting fumes. Several other applications of the device are mentioned.

1680. Kelly, C. D., Pady, S. M., and Polunin, Nicho-
olvas. Aerobiological Sampling Methods From Air-

Three methods are described for sampling airborne bacteria and fungi from aircraft. These methods were designed for use in aircraft flying at speeds of about 200 m. p. h. The first is a qualitative method for use in a B-29 aircraft, with a sampling tube to hold a Petri dish 12 in. in front of the nose, yet permit loading and unloading from the interior. In the second and third methods, which are quantitative, the sam-
plers are located inside the aircraft and air is brought to them by rubber hose connected to 1 in. Al elbows in a side window: the sampled air leaves the aircraft by another Al hose and elbows. The second sampling method uses a G. E. aerobiological bacterial air sam-
pler located in an Al sampling chamber 18 in. x 18 in. x 18 in. The third method utilizes filters made from glass wool and lamps paper disks mounted in brass hose con-
nections. The number of organisms was calculated on a cubic foot basis from colonies that developed on nutrient media. In the second method, the organisms were precipitated directly on the agar surface; in the third method, however, the filters were shaken in sterile water and aliquot portions cultured in agar plates. For studying the numbers of fungus spores, slides were substituted for agar in Petri plates exposed in the G. E. sampler. Typical results are given for the two quantitative methods. (PHEA)

1681. Keizer, J. [Aspiration of Dust and Material Re-

Brief discussion with illustrations of machinery. (CA)


The need for standards of measurement of air pol-
lution is stressed. Refers to studies made in Great Britain and Canada in which very valuable data on the nature and extent of air pollution have been collected without elaborate or expensive equipment.

The study, made in St. Louis in 1930-31 and in 1939, illustrates the importance of systematic sampling in the initial evaluation of the air-pollution problem and in measuring the effectiveness of remedial measures once they are in operation.

Such comparative studies show that the use of low-
sulfur fuels has helped to reduce sulfur dioxide con-
centrations in downtown St. Louis, Mo., by as much as 83 percent in winter and 73 percent in summer. (5 refs. cited)

1683. Mining Engineering. Directional Dirt Collector for Smo-

A new instrument for use in analyzing air-pollution problems in highly industrialized areas has been de-
veloped by Battelle Institute. The dirtfall collector is designed to collect heavy dirt from any direction the wind is blowing. A so-called wind-rose pattern shows the number of hours the wind has blown from the eight points of the compass. Knowing this, it is then possible to determine the relative amounts of dirt that have fallen per hour into the instrument from the various directions.


The seriousness of the problem of contaminants in

air depends not only on density of contamination but also on the surroundings. If no population center or valuable vegetation is near by, natural dispersion may so dilute the contaminants as to make them harm-
less. If air pollution and its economic control are to

be understood, the first step must be development of a
technique for measuring the amounts of contaminants in the air over and around industrial areas.

Nearly all studies of air contaminants have been based on sampling at ground level. However, it is also necessary to study the concentrations of contaminants at various altitudes over the area involved and their movement under various meteorological conditions.

It is important, therefore, to consider the methods that are available for studying the concentrations of air contaminants and the meteorological elements that control their movement in the first few hundred or few thousand feet of the atmosphere—the "earthbound contaminant layer" of air.

A method, known as the Battelle technique, has been developed for elevating various instruments to low altitudes for scientific observations. It consists of using one or more kyotons (kite balloons, which derive part of their lift from helium and part from air move-
ment) as a skyhook. In this way, measurements or sam-
plings may be secured continuously from the desired altitude and along any desired line.

1685. Naumann, A. [Methods for Automatic Analysis of


A survey of new gas-measuring methods and appa-
ratus. Numerous data are expressed by curves, for example, combustion losses as a function of the air-

ratio; composition of flue gases with powdered-coal firing; thermal conductivity of air and carbon dioxide; carbon dioxide and oxygen content of flue gases with various fuels and with different amounts of excess air for lime and cement kilns, etc. (APB)

1686. Pestel, E. [Model Laws and Tests for Determining


1687. Polezhaev, N. G., Gerina, V. V., and Laktunova,
T. E. [Micromethods for Determining Harmful Sub-

Micro-determinations are outlined for determinations of CI by absorption in alkali, treatment with NaSO4, oxidation of sulfite compounds by H2O2, and photometric determination of CI as AgCl. H.S. (colorimetrically as AgS after absorption in Na arsenite solution), SO4 (by absorption in KClO3 and determination of SO4 as BaSO4, nephelometrically), Pb (nephelometrically as chromate), and Hg (nephelometrically as CuHgI4, (AIHOM)


The larger solid particles were counted up to 2,200 meters above the ground with a Zeiss conicometer. The mean vertical distribution decreased exponentially, falling to 1/4 of ground value of 500 meters in winter and 1,500 meters in summer. The distribution is the same as for condensation nuclei and haze particles. Particles could be counted down to 0.15 - 0.2 micron but as the number increased rapidly with decreasing size, the totals have little absolute meaning. A possible source of error is discussed. (PHEA)


A general review of the measuring of atmospheric pollution and the testing of industrial and domestic appliances at the Fuel Research Station. (APB)
The new air sampler is a practical and efficient device for determining airborne dust and especially fume. Soluble dust and fume may be removed easily and completely from the filter and determined by any analytic procedure desired. The materials used in the sampler contain no organic matter and, therefore, present no analytical difficulties arising from this source. The sample does not have to be transferred to another container—it can be sealed immediately after the sample is taken, so that there is no chance of loss or contamination. Being rugged and a dry sampler it presents no special difficulties in shipment. It may be used either vertically or horizontally. It is recommended for use by industrial hygienists for determining airborne non pneumoconiosis-producing toxic particulate matter. (Author's summary)


Previous attempts to concentrate air pollutant in a cold trap and analyze the concentrates by mass spectrometer have had disappointing results. A new method by which the air of Los Angeles County has been examined, combines the isolation of gaseous pollutants and the determination of the isolated frozen concentrate by isothermal distillation or sublimation at low temperatures and pressures, and identification and estimation of distillates by the mass spectrometer. The method can detect as low as 10,4 p.p.m. of some pollutants from a 100-liter sample of air; with larger samples, 0.000001 p.p.m. of some substances can be determined. The gaseous phase of the Los Angeles smog was found to be of the order of 0.5 p.p.m. of the air. About 60 chemical compounds or families of compounds were identified or tentatively identified, and the amounts of some of these were determined. It was shown that the gaseous phase of the smog was primarily a mixture of hydrocarbons, and of hydrocarbons combined with oxygen, nitrogen, and chlorine. Most important, these hydrocarbons, principally the unsaturated ones, when oxidized with ozone and nitrogen dioxide (both known to be in Los Angeles air) in the presence of ultraviolet light, produce substances that constitute a large portion of the smog concentrates. These oxidation products cause eye and respiratory irritation, such as are produced by the real smog, and smell like the smog and its concentrates. Haagen-Smit has experimentally shown that these products cause the specific types of plant damage observed during actual smogs, and the present work offers substantial proof of the Los Angeles smog. Unexplained residue in the mass spectra of the smog concentrates may eventually indicate the presence of other irritants. The new method may be applied to special problems in air pollution over large areas or inside industrial plants. (PHEA)


Increase in airborne dust is measured in terms of a time parameter. An empirical relationship between a simple time parameter and the weight (1-30 mg.) of dust is noted. Two types of apparatus have been used. In one type of apparatus, the air flow through the dust and paper is made electrically. In the second type, the time of the rise between two fixed points of liquid aspirating the air through the dust and paper is noted by an observer using a stop watch. Tests in an artificial coal-dust cloud and in a coal mine show that the method measures changes in concentration of the dust cloud of moderate concentration, and has certain advantages over other methods. Theory suggests that the method estimates the surface-area concentration of the dust. (PHEA)


The method is based on the color reaction of sulfur dioxide with fuchsin in the presence of formaldehyde and sulfuric acid, and it can be used to estimate the sulfur dioxide content of the external air or of that in manufacturing plants.

The standard, all-glass impinger contains 100 ml. of a solution of glycerin in sodium hydroxide. Sampling is at the rate of 1 cu. ft. per minute, and up to 30 cu. ft. may need to be sampled when the concentration is as low as 0.5 p.p.m.

Some of the color reagent, prepared as described in the paper, is added to a small quantity of the collected sample, and after 15 minutes is measured with the spectrophotometer. A standard curve is derived from measurements with standard sodium bisulfite solutions.

Glycerin is used in the collecting solution as an inhibitor of oxidation. Light interference is avoided during the analysis by using darkened flasks. Hydrogen sulfide can interfere with accuracy, but a concentration of 0.1 p.p.m. of this gas did not have any material effect. The method is sensitive and quick. (BSH)


Sulfur dioxide may be determined in air in concentrations as low as 0.01 p.p.m. by absorbing in 5 percent glycerol 0.1 N sodium hydroxide solution. Ten ml. of the sampling solution is used in a midget fritted-glass bubbler, and 10 l. of air are passed through it at a rate of 20 l. per hour. An aliquot of the sample is mixed with the color reagent (a mixture of basic fuchsin, sulfuric acid, and formaldehyde) and read in a spectrophotometer or colorimeter at a wave length of 580μ. Interference may be eliminated by precipitation with mercuric chloride before adding the color reagent. (A1HOM)

1952.


Very little information seems to be available regarding the inventor of the Ringelmann chart and virtually nothing on his invention of the chart. He is said to have acquired an erudition without equal through his personal studies, his experiences, and the missions with which he was charged in France and numerous foreign countries—even the United States and Canada.

He died in 1931 at the age of 70. Of his numerous works and reports only one—Charcoal, the National Fuel—seemed to have some bearing on his studies that led to formation of the chart. (BSH)


Describes measurement of airborne solids deposits by using dustfall jars, which has been in effect in Cincinnati for 20 years. The data collected over this period is valuable as a yardstick with which to compare particulate matter deposits in localities and during specified time periods.

The capabilities and limits of an automatic air sampler, which was selected as the basic equipment for the program, are discussed. Details are given of the operation and results of these methods of determining air pollution.

A 20 to 50 gram sample of hay dust, dried to constant weight at 120°, is moistened with 1 ml of N calcium acetate per gram of hay, in a nickel crucible. After drying, cautiousashing, and igniting, the residue is transferred to a platinum crucible and further ignited for 15 minutes. The ash is mixed thoroughly. A 0.01 to 0.8 gram sample is placed in a V–2–A crucible, and about half its weight of Mg powder is added and the mixture ignited continuously to reduce PbO and CO2, which interfere in the subsequent AlCl3 distillation method described previously. Values are reproducible to 10 percent for amounts of 1–48 mg of Pb. (APB)


Methods for sampling and analyzing fly gases from steam-raising appliances, heating boilers, and processes for manufacture of iron, steel, nonferrous metals, pottery, refractories, heavy clay ware, food, cement, glass, certain chemicals, and coal gas are given. The Orsat apparatus for determining carbon dioxide, oxygen, carbon monoxide and the Haldane apparatus for carbon dioxide, oxygen, carbon monoxide, hydrogen, and methane are described. (APB)


Discuss some new processes and procedures that were developed as a result of subsequent investigation in Los Angeles. The portion-scattering technique, introduced into air-pollution studies for the first time in this work, is treated.


The present method belongs to the class of aerosol particle size determinations in situ.

A slowly rising dust cloud, exposed to a horizontal sound wave, is dark field illuminated and photographed through a microscope. The oscillations of the particles, recorded as sinusoidal tracks, are described on the basis of Stokes law.

The method has been applied to atomized aluminum dust, covering the size range from 30 to 3μ with frequencies from 100 to 3,000. Data obtained are discussed. Measurement of aerosol particles in general would require ultrasonic frequencies. With these, an extension of the resolving power of the microscope appears possible, as far as amplitudes can be determined accurately.


The midget-impinger method of analyzing dust provides information on the quantity of solids present in air expressed in terms of millions of particles per cubic foot. The apparatus consists of a hand-operated vacuum pump and an impinger tube. The pump is used to draw the dust-laden air through the tube at a known constant rate, and the tube is used to remove the solids from suspension. The latter is accomplished by having the suspension pass through a small orifice at high velocity and impinge on the bottom of the tube. The solids are momentarily stopped, wet by the liquid, and thus removed from the air.

In spite of its wide application for dusts of all types, the method has limitations that must be considered when evaluating results. The limitations are concerned with the collection of the sample, the stability of the sample in the collecting medium, and the technique used in particle counts. The midget-impinger method is purely empirical, and the results are only relative. Nevertheless, reasonable agreement has been obtained with other methods based on filtration and sedimentation.


The aerosol suspension passing through a small aperture is indirectly illuminated by a high-speed, high-intensity flash source focused on the aperture by a dark field condenser. As the suspension is unaltered from its original condition, measurements of total concentration, and estimates of particle size are facilitated. The difference in appearance between liquid droplets and solid particles is discussed, together with methods for estimating particle size and distribution. Data are presented on the lower limit of particle size that can be photographed.


The light received from one or more distant targets is measured by a long-focus lens on a photocell and amplified, and the output is recorded by a Leeds & Northrup Micromax strip-chart recorder. A sequencing device is used so that the zero point, the light intensities from each target, and the sky illumination are each recorded in turn, and the cycle repeated every 10 minutes. Usabilities may be calculated by the method described by Steffens, in which optical densities of photographic negatives of the targets were used to measure the respective light intensities. The relationship of the target distances to accuracy of measurement is discussed. Usabilities over the range 2½ mile to 10 miles are covered by a given set of targets.


A program initiated in 1946 to measure the quantities of particulate matter and especially the quantities of lead in the atmosphere was gradually expanded, as opportunity was afforded, into a program for investigating certain more general characteristics of the air pollution of Cincinnati. The work was sponsored largely by industry as part of a long-term investigation of the occurrence and the physiological significance of lead in the human environment. Two grants of funds by the United States Public Health Service aided in financing the work for 24 months during the years 1947–50.

In the initial stages of this work 12 sampling stations were selected with respect to prevailing wind directions, industrial and automobile activity, density of population, density of traffic, and altitude. At each of these stations samples of suspended matter were collected by an electrostatic precipitator and were analyzed gravimetrically, spectrophotographically, and chemically to determine the total quantities and the composition of the particulate matter suspended in the atmosphere. Although the initial purpose was to ob-
tain information on the quantities of respirable lead in various sections of a characteristic American city and to establish eventually the major sources of such lead, the need for other basic quantitative data on the nature of the atmosphere of an industrial community led to a gradual widening of the scope of the investigation. During the course of observations carried on contin-
ually in the Cincinnati area from 1946 through 1951, careful consideration was given to the selection and development of suitable analytical methods. This report is concerned with the nature and quantities of some of the commoner materials, which were found to be present in the atmosphere.

1705. Cotton, P. E. (Assigned to Factory Mutual Re-

This gas detector consists of two resistance elements connected in a Wheatstone bridge. The elements are identical except that the core of one is impregnated with a platinum or platinum-rhodium catalyst. This arrangement causes one element to be more active than the other in the presence of a flammable component. (APB)


If a plate on which some powder is placed is tilted, the powder will slide off at once at a certain angle of tilt. This is a function not only of the friction but of a force inversely proportional to particle size. The proportionality factor is characteristic of the material and of the plate. (APB)


The method described was developed as a result of general dissatisfaction with the accuracy and repro-
ducibility of several colorimetric procedures used for the control evaluation of cyanides in refinery waste effluents. A method, which is based on the reduction of sodium picrate by cyanide to form a colored product, is presented for the quantitative determination of cyanogen and hydrogen cyanide in refinery stack gases and of those cyanides in refinery waste waters that are readily decomposed by strong acids. The determination is sensitive to 1 p.p.m. and accurate to within 2 percent of the correct value; the developed color is stable, and the determination is not affected by other substances normally encountered in refinery wastes. A comprehensive discussion is presented of the varia-
ties affecting the picrate-cyanide reaction, such as re-
action rate, reagent concentration, color stability, and interfering substances. The presence of sulfide or sulfur dioxide does not interfere with the determination. The procedure has been used for more than a year for refinery control. (AHOM)


The unit of measurement is the Ringelmann number. A smoke density of Ringelmann 1 corresponds to max-
imum combustion efficiency. The principle of a smoke meter, which consists of a light source, a photoelectric cell, and an indicating or recording unit, is described. Practical factors in the choice and maintenance of smoke meters are discussed. (APB)


Spectrometric methods, mass, infrared, and ultra-
violet, have been applied with considerable success to analyses of both organic and inorganic compounds. These methods are being used routinely to analyze complex mixtures of isomers in the fields of chemicals and volatile fuels. Examples include quantitative analyses of most of the constituents of gasoline, of aromatic hydrocarbons through the C's, etc. Application of these methods to tracer work has produced results such as quantitative analyses in methane decom-
position products of 7 hydrocarbons, total concentra-
tions of which were less than 1 percent. Examples of many spectrometric analyses may be found in the literature.

Use of these methods on samples of Los Angeles air pollutants from freezeout trains has resulted in identi-
fication of four nonhydrocarbon organic compounds. These constituents appear to be localized and to have no connection with the lachrymation problem; but other spectral evidence shows promise of further identi-
fi cation, which may lead to a solution of the problem.


An automatic sulfur dioxide recorder was purchased by the Division of Occupational Health, United States Public Health Service, and has been in use for slightly more than a year in the Detroit-Windsor air-pollution study. This study is being conducted by local, State, and national governmental health agencies of Canada and the United States under the auspices of the Inter-
national Joint Commission. The area being studied extends the length of the Detroit River and inland for 15 miles on either side.

The instrument measures very small concentrations of sulfur dioxide and other soluble gases in the air by means of electrical conductivity. A measured quantity of air is fed countercurrent to a measured quantity of absorbing solution inside a uniformly heated cabinet. The absorbing solution consists of 2 to 4 X 10^{-3} N hydro-
gen peroxide in 5X10^{-3} N sulfuric acid. The sulfur dioxide in the air is absorbed and oxidized, increasing the conductivity of the solution, which is recorded as parts per million of sulfur dioxide.

Problems arising in connection with the use of the recorder in the Detroit-Windsor study are discussed.


More than 14 cities are conducting dustfall studies, and there are only two procedures common to the work:

(1) Jars are set out monthly, and the results are re-
ported as tons per square mile per month.

(2) To the average citizen, tons per square mile per month in Pittsburgh, Columbus, and Cincinnati are com-
parable; to the air-pollution-control engineer, they are as different as pears, peaches, and pomegranates. The man-
son without some measure of standardization is abso-
lutely meaningless. Why not standardize? Some say it can't be done, because the identical situations cannot be set up in city for city. That is true, but there are many items that could be standardized by simply agree-
ing on the best procedure.

Ten items are cited that should be considered in working toward standardization.

1712. Guerke, F. T. Instrumental Methods of Measur-
ing Mass Concentration and Particulate Concentra-

Fundamental studies of aerosols and evaluation of so-called filters require use of the particle methods of measuring the mass and number of particles suspended in a sample of air. Older visual microscopic methods recently have given way to instrumental methods, which may be made automatically recording.
The mass concentration of a uniform aerosol may be determined by illuminating it with a strong light, focusing some of the scattered light upon a photoscell, and measuring the photocurrent potentiometrically. Several years ago, a direct-reading penetration meter was developed, suitable for testing the best respirator filters, sensitive to 10⁻³ gm./l of dioctyl phthalate aerosol of 0.5µ diameter. More recently an instrument 50 times as sensitive has been made. This apparatus can be used for measuring or controlling the concentration of material in a dilute aerosol.

A photoelectric particle counter has also been developed in which the aerosol flows through a cell under intense dark-field illumination, the pulses of scattered light are collected upon a photosensitive tube, and the resulting electrical pulses are amplified until those above a selected value activate an electronic or mechanical counter. This instrument will count spherical aerosol particles down to about 0.5µ in diameter, at rates up to about 1,000 per minute.

An electrostatic method of counting particles draws the aerosol stream through a small hole to impinge on a charged collector.


One of the special features in the chemical analysis of the air pollutants is the presence in most cases of only small amounts of material in a large volume of air. The state in which these pollutants are present—as gases and aerosols—presents additional difficulties. It is of the greatest importance to be able to collect the material, and for this purpose several techniques have been proposed and used.

One of these methods consists of cooling the air and freezing out the volatile material. In this way, dilute aqueous solutions are obtained, containing some of the agents in more concentrated form. Considerable improvement of this method is possible when it is combined with absorption techniques, whereby more volatile substances and aerosols can be caught. For isolating special groups of substances, scrubbers, impingers, and electrostatic and thermal precipitators can be used.

When the material has been collected, the inorganic constituents are determined by well-established microchemical methods. For the organic impurities, the collected material is heated to be separated into different classes of organic compounds, and fractionation and identification have to be carried out. The chromatographic method, which allows the separation of very closely related organic compounds, is very useful here.

During the collection, unstable compounds originally present may be decomposed, and in addition, interaction of different components is to be expected. The chemical analysis will therefore show the end result of a series of reactions between a number of air pollutants and the interpretation of the results must take these facts into consideration.


The use of measurements of particulate mass for evaluating air-pollution levels is discussed. A volume of air (25 cu. ft.) is drawn at a uniform rate through a 1 sq. in. area of uniformly white filter paper of high quality (for example, Whatman No. 52) during 1 hour. The darkening of the paper is measured by the light reflected by the deposit when compared with that reflected from clean filter paper by the reflectance attachment of a Beckmann spectrophotometer at λ 400 µµ. The readings are recorded in terms of the optical density scale of the instrument, log 100/R, where R is the percent reflectance. For comparison the readings are converted into scale of the µgm. values, the equivalent of the deposit per m². A unit value is defined as the deposit that produces an optical density of 0.1 when the deposit area is 1 cm², and the volume of air sampled is 1 m³. For a sample volume of 25 cu. ft. and a filter area of 1 sq. in., K = 91 Dk, where Dk is the optical density equivalent for R. The value of K for the Los Angeles area ranges from 2-20. The chief constituents of the deposit, carbon and tarry matter, have been estimated by drawing samples of 170 cu. ft. of air through a Gooch crucible with an asbestos pad and oxidizing the residue with acidified aqueous potassium bichromate calibrated in terms of carbon. The average carbon content is approximately equal to 10 µg. per cu. m² for unit K. As a measure of particulate mass, Dk has various limitations, for example, it does not vary uniformly with the mass of the deposit, which is not completely black, Dk increases gradually with increase in λ, and the albedo of the deposit is not zero at 400 µµ.

An automatic sampler is described and analyses of various samples are tabulated. The average composition is C, 55.3%; Al, 5.5%; Ca, 5.7%; Cu, 0.2%; Fe, 6.6%; Mg, 11%; Pb, 3.4%; and Si, 21.3% percent. The average hourly K values for 24-hour periods and general weather conditions and visibility are discussed. (APB)


The importance of the correlation long-term exposure to minute concentrations of contaminates in the air with physiological response data is emphasized.

Air-pollution engineer must continue to determine the nature and extent of atmospheric pollution upon which these studies can be based and which in the future may prove to be important in diagnosing ill health in certain elements in the population.

The ideal instrument for measuring aerosols in the atmosphere is yet to be developed. The attributes such an instrument should possess are described.


A widespread difference of opinion exists among control officials concerning the significance and value of dustfall measurements. The importance of this measurement is emphasized by evidence that it is recognized as a quantitative indication of the average weight of large particles raining out of the atmosphere onto horizontal surfaces at a particular location.

The reasons for the divergence of opinion are given. It is often alleged that it does not give a true index of a city's smoke problem and does not therefore properly reflect improvements in smoke abatement.

This expresses a misconception concerning the basic difference in both origin and character of fuel smoke, on one hand, and fuel (or other) dust, on the other. They are two different problems requiring two different methods of detection and two different kinds of corrective measures.

Another point frequently and properly emphasized is that comparison of dustfall rate between different cities is not permissible. The most important bar to valid comparisons is in the failure to classify and average dustfall figures according to the types of districts in which they were obtained.

Dustfall figures fluctuate widely in consecutive months. It will be found that if results are averaged for the several months of a single season (and for particular types of districts), these fluctuations dissolve, and remarkably stable figures of high significance result.

Although sulfur dioxide, sulfur trioxide, and hydrogen sulfide are in all probability the major sulfur-bearing air pollutants, other sulfur compounds may be present. Among these are carbon oxides, carbon disulfide, hydroperoxydisulfates, many organic compounds, such as the mercaptans and organic sulfides, under special conditions carbon disulfide, and also free sulfur itself. Since the exact part that these and other compounds play is not known, it is advantageous to have methods available that will differentiate these pollutants. Methods of sampling and analysis can be arranged for separating the various sulfur pollution components. Thus sulfur trioxide, sulfuric acid, the sulfates, and free sulfur may be trapped by an acid-free filter paper whereas sulfur dioxide, for instance, being a true gas, will pass through. The sulfur trioxide may then be estimated titrimetrically as sulfuric acid. Total sulfate can be determined by a procedure (1), by subtracting the acid equivalent, the amount of sulfate can be ascertained. Free sulfur can be detected and estimated by a variation of the mercury doctor test. Sulfur dioxide may be estimated by a variety of methods that enable it to be distinguished from sulfur trioxide. A new method for its determination in air is detailed. Hydrogen sulfide may be estimated by the silver cyanide detector and by other methods. In an analogous way, methods for other possible sulfur-bearing air contaminants are described.


The number of constituents in contaminated atmosphere is as yet unknown. Although methods of analysis exist for the common gases from industrial pollution and a general idea of their prevalence has been obtained, there are many organic vapors and components that may exist at concentrations above those for threshold physiological effects.

The gases and vapors in contaminated air are of interest mainly from their chemical behavior, whereas the physical properties of aerosols of suspended particulates are of most concern. Innoxious gases and vapors may be converted to obnoxious compounds by reaction with other contaminants in the presence of sunlight, or by reaction with oxygen of the air. These secondary reactions may be the source of eye-irritating materials formed from partly decomposed and incompletely oxidized organic compounds. Sulfur dioxide present in the atmosphere below the limit of detection by physiological response or the effective limit for damage to vegetation, is converted to sulfur trioxide by spontaneous oxidation in the air in sunlight, and by absorption by water droplets to produce sulfuric acid mist, which is one of the principal causes of low visibility.

The most effective particle size for scattering light, and thus in reducing visibility, is in the range from 0.3 to 0.6 μ. A large percentage of the integral dust, fume, and mist is in the submicron range. Such particles do not settle out of the air but are dispersed in the same manner as gas discharges. Concentrations of aerosols at ground level may be estimated for normal meteorological conditions. Meteorological and topographical conditions to a large extent control the degree of pollution from domestic and industrial sources.


The modified cascade impactor is a multiple-stage aerosol sampling device used for characterizing atmospheric contaminants in terms of particle size and concentration. Excellent results are obtained in the range between 0.2 to 5 μ. The design permits interchangeability of model, accurate slits, and the sturdiness and duplication of construction required for practical use. In principle, the instrument employs a series of four jet deaccelerating areas and collecting slides arranged in tandem. These are followed by a fifth sampling stage in the form of a filter paper. Streamline design and the use of rectangular orifices permit the continuous flow of an air stream through the instrument with a minimum of loss and with collection efficiency. Particles are deposited on successive slides largely through their inability to follow the course of the air stream owing to their relative momentum and the low viscosity of the air. The filter-paper design efficiently samples the potential collection of fine particulates that completely pass the smallest jet.

The problems of shattering of larger particles at velocities required to impinge the smaller sizes found in single jet sampling devices are largely overcome. In addition, the size selectivity of such devices is used to advantage in the cascade impactor for segregating different size fractions of the total particle-size distribution.

The special advantage of the modified cascade impactor, however, has been in the development of a procedure whereby particle-size mass distribution can be determined by a chemical or physical analysis of the total particulate mass collected at each stage without resorting to counting the particles or measuring their diameters. The procedure of indirect analysis eliminates the laborious and time-consuming factors in particle-size analysis and has enabled the cascade impactor to become practical for large-scale routine problems. Results in agreement with theoretical calculations have been obtained and also verified by direct electron microscopic measurements of samples collected simultaneously with a thermal precipitator. The modified cascade impactor has been applied in the characterization of dust and mist atmospheres of uranium and beryllium compounds. In both laboratory and field problems it has proved its value as a sturdy instrument yielding rapid and reliable results. The instrument may also be used for the size distribution analysis of a mixture of dusts such as is frequently encountered in many industrial atmospheres.


Dilute solutions of starch-iodine have been found suitable for the continuous determination of low concentrations of sulfur dioxide in smelter areas where hydrogen sulfide is not likely to occur. The most effective concentration range of solution is from about 7×10⁻⁴ Normal to 2×10⁻⁴ N. The apparatus for continuous recording of SO₂ consists of a Thomas analyzer, two gas bubblers containing 100 ml. of solution mounted in a block with a light source between them, and two photoelectric cells (Weston, Model 594). The output current of the photocells is passed through a standard resistance box, and the voltage drop across the 0-500 ohm terminals is measured by a moving potentiometer with a scale range of 0-50 millivolts.
The instrument has a range of less than 0.01 to 1.00 p.p.m. or more, depending upon the size of the gas sample and the volume of solution used in the absorption tube. It has been used for several seasons to determine the SO₂ content of the air at a location in the Sudbury smelting district.

Comparative tests of the iodine and H₂Oₐ conductivity methods have been made with a portable apparatus on simultaneous samples of air in the path of the smelter fumes. The results indicate that a substantial fraction of the smelter smoke during a fumigation may consist of SO₂, HSO₃⁻, or sulfate.


A voluminous literature on air pollution is now being laid down from efforts to meet the growing problem of industrial and domestic effluents. Analytical methods of the postwar period are summarized here and those trends that may be expected to influence the determination procedures of the future are delineated. The notable esti.viation during the period has been the Los Angeles smog investigation, in which methods of wide diversity and great ingenuity have been employed by both the county group and Stanford Research Institute. In the field of field new engineering developments and advances in technology have focused attention on sub-micron particles. Thus there is increasing application of the electron microscope and accelerated work on collection techniques that avoid agglomeration or dispersion effects. Gas and vapor analysis is marked by clever exploitation of spectrometry: Infrared and mass spectrometer methods are gaining ground. There is emphasis on low-temperature-collection procedures. New understanding of the important effects of meteorological variables combined with increased laboratory costs to establish the importance of direct-reading continuous techniques, both for control and environmental exploration work. New developments in such apparatus are being vigorously pursued. There is stronger emphasis on laboratory study of air-pollution systems, a trend that may influence analytical field methods of the future. (102 refs. cited) (Author's summary)


In addition to the overall study of the atmospheric pollutants in the Detroit-Windsor, Ontario, Canada, area, an exploratory regimen of sampling the general air was undertaken to obtain background material for subsequent biological and engineering investigations. Quantitative and semiquantitative data were obtained on the inorganic air pollutants for assistance in medical planning and interpretation, correlation of variations with meteorological factors, knowledge of variations in pollutants and concentrations with regard to location, and estimation of the relative contributions of certain industrial sources of pollutants. It was decided to concentrate on particulate contaminants containing metallic elements and to conduct semiquantitative estimations by a spectrographic procedure. Samples were collected daily for 6 weeks at 31 stations. More than 1,200 samples were submitted for estimation of 21 elements in each. Results were obtained from 21,000 determinations in 4 months. Although not as accurate as chemical or quantitative spectrographic methods, it accomplished the purpose in this exploratory study.


The objective of this research was to develop methods of producing, detecting, and measuring rapidly and quantitatively not only aerosol droplets but also sub-micron SO₂ or sulfate.

The sizes of homogeneous aerosol droplets following controlled growth are easily measured by a variety of optical methods, developed previously in the Columbia University Laboratories for a size range terminating at the approximate lower limit of 0.05 μ radius.

The homogeneous aerosol generator of La Mer and Sinclair can be used for the production of exceedingly small particles; 99 percent H₂O₃ and dibutyl phthalate have proved to be suitable examples. The lower limit of size production appears to be the critical nucleus (radius approximately 10⁻¹ cm. or 0.001 μ); the smallest radius measured by the present growth method is about 0.01 μ, although smaller sizes of the order 0.006 μ are detectable and these sizes can be simulated crudely.

The present study indicates, and there is no evidence to the contrary, that all liquid aerosols when exposed to the atmosphere of a miscible and volatile solvent can be grown under controlled conditions.

In the case of 99 percent H₂O₃ measurements can be made following growth by a factor as large as 8 fold in radius (512 fold in volume or an increase in the intensity of light scattering of roughly 4,000 to 250,000 fold, depending upon initial radius). The control of growth is more reliable the smaller the growth. Fivefold is recommended.


Most of the important properties of aerosols, such as optical obscurity, deposition, evaporation or condensation, thermal and electrical precipitation, filtration, insecticidal toxicity, etc., are strongly dependent upon the particle size of the disperse phase; hence, the measurement of size is of paramount importance in characterizing an aerosol. Unless all the particles are of the same size, it also becomes necessary to know the form of the distribution function and the parameters specifying it. All of these difficulties can be avoided by working with monodisperse aerosols, where a single parameter, the radius of the droplet, suffices for a description of their properties.

Apparatus designed to accomplish the following are described: (1) The production of various monodisperse aerosols for various purposes. This method has recently been extended to 0.02 μ for accurate measurement of radius and to 0.005 μ for detection. (2) Several types of optical methods for size determination, including a forward angle Tyndallimeter, which has proved useful for detecting 10⁻⁵ gm./l. (10⁻⁹ gm./cc.) of aerosol in the study of filtration. This exceedingly sensitive optical scheme employs only readily available visual techniques. (3) Determination of polydispersity by a combination of sedimentation and optical techniques. (4) Collection and sampling of aerosols, including recent investigations in electron microscopy.


Rainfall collections at six points were analyzed to measure the periodicity of the aerosol. Pres. at 5th Tech. Conf. on Air Pollution, Analytical Methods and Properties Panel, Washington, D. C., May 3–5, 1950.
were exposed to measure progressive intake of fluorine from the atmosphere. Longer intervals between rainfall caused higher concentrations of fluorine at the several locations. Proximities of samplings to sources of emissions were reflected by higher concentrations of fluorine in rain waters. Exposures of Spanish moss acquired substantial progressive enhancements in fluorine uptake at points near those where fluorine emissions occurred. The findings demonstrate that these two feasible and economical procedures can be implemented in parallel to establish whether a particular locale is subject to atmospheric pollution and the degree of pollution. Through integration with meteorological records, the determined occurrences of fluorine in the rain waters might indicate the origins of the contaminative effluents. (8 refs. cited) (Authors’ summary)


The soiling property of atmospheric dust is of major economic importance in heavily populated areas. Because this property is due to a considerable extent to the proportion of free carbon present, design and test studies in the air-cleaning industry have made necessary the development of a convenient analytical method for the determination of free carbon in this dust. (3 refs. cited) (Authors’ summary)


The use of opacity readings as a potential means of reducing pollution is suggested in connection with the use of the Ringlemann chart. The Ringlemann chart provides five distinct shadings of gray and is used as a guide in determining the density of black smoke. Its practical use has been demonstrated for many years. Emissions of any color can be compared in their visual obscuring quality (opacity) with the various shades of smoke that are indicated on the Ringlemann chart.

To use effectively opacity percentages of emissions that are other than black as a tool in enforcement, one has but to compare these opacities with the visibility obscuring value of black smoke. Black smoke of No. 1 Ringlemann density obscures an observer’s view by 20 percent and therefore has an opacity of 20 percent. Similarly, No. 2 Ringlemann black smoke has an opacity of 30 percent; No. 3 Ringlemann, 60 percent; No. 4 Ringlemann, 80 percent; and No. 5 Ringlemann, 100 percent. An emission of any color that completely obscures an observer’s view, obscures his view by 100 percent and therefore has an opacity of 100 percent.

By properly relating percent opacities of all colors of emissions with the visibility obscuring value of Ringlemann black smoke, a very definite and practical means is available for judging the emissions from many sources.

To use effectively the Ringlemann chart and opacity readings as enforcement tools, the inspector must, of course, be supported by an adequate law. Control laws, ordinances, and codes must be worded in such a manner that the density of emissions of any color are included in their prohibitions.


Methods of determining concentrations of contaminants are described including a new dirtfall-measuring apparatus, aerosol meters, and the use of the kite balloon and hot wire anemometer for measurements in the lower atmosphere. The need for studying individual plants for economical methods of reducing concentrations of contaminants is emphasized. (ABP)


In air-pollution studies, the particle size and distribution of particle sizes of the contaminants are of great importance. It is necessary in selecting the proper techniques for sampling the contaminants, in choosing the proper equipment for removing them from the effluent gases, and in determining the area over which they will probably fall. The particle sizes that may be expected from certain sources are listed. The methods available for sampling and equipment for removing contaminants of various particle sizes are given.

Many so-called contaminants have proved to be valuable byproducts. The real challenge to research is to find uses for the new materials being separated from contaminated industrial gases.

Most of the air sampling has been at ground level. Many of the air contaminants are aerosols and do not settle to the ground rapidly. The new Battelle technique makes it possible to continuously sample air for particulate matter or gases up to 500 feet and higher. Meteorological data have been obtained by the Armed Services up to 2,000 feet using this technique. Data and air samples from these altitudes should increase our understanding of the nature of smogs and air pollutants over our population centers.


A definition of air pollution is given, and types and sources of contaminants are discussed. Precautions must be taken during continuous dirtfall measurements to insure reliability are indicated and methods of determining aerosol concentrations described. Methods of abating smoke and reducing fly ash are considered. (APB)


The instruments most widely used for measuring atmospheric pollution in Great Britain are (1) the standard deposit gauge, which measures the total deposit in a given locality during a 1-month period; (2) the peroxide instrument, for estimation of the comparative concentration of sulfur dioxide in the air over 1 month; (3) the volumetric smoke apparatus; and (4) the volumetric sulfur dioxide apparatus, which measures over a 24-hour period the average concentrations in the air in smoke or other suspended impurity and sulfur dioxide, respectively. A description of these methods, which have been standardized for use by organizations cooperating in the investigation of atmospheric pollution, is given and their limitations are discussed.

Other instruments that have found application in Great Britain include the automatic recording air filter, the jet dust counter, and the thermal probe. The methods are described in the following chapters.


The improvements in the construction of the L & N recording Thomas Autometer and its limitations are reviewed. It is suggested that immediate attempts be
made to establish reasonable specific requirements, which are needed by users of this method of measurement.

Suggestions are made relative to a few important features; it is stressed that the simpler the type of measurement the less will be the maintenance.


An automatically operated optical device is described, which scans a transparent photograph of spray droplets and determines the curve of relative frequency versus drop diameter. The photograph contains magnified, opaque images of the individual droplets. These images interrupt a parallel light beam of rectangular cross section as the photograph is moved through the beam. One count is registered by an electronic device each time the beam is totally obscured. The size-frequency curve is computed statistically from the influence of beam width on the number of counts registered.

The instrument has an advantage over direct observation and measurement of particles under a microscope since results are obtained more rapidly by a technique that does not involve personal errors. The method is limited to sprays that can be clearly photographed, usually after collecting a sample of the droplets on a greased slide.


Relatively dense air-pollution haze was sampled by means of simple modifications of the jet impactor and the electrostatic precipitator. Microscopic observation indicates that the visible pollution consists mainly of stable liquid aerosol particles. It is suggested that these droplets are similar in composition to the smaller condensation nuclei commonly found in industrial urban atmospheres.


A portable method of measuring diffusion consists of lifting smoke-puff generators with tethered balloons, sending off puffs remotely, and photographing them with two picture cameras. From the resulting records of a real spread of smoke and distance of travel, one may compute values of diffusion coefficients. Preliminary experiments yield data in accord with those published by Sutton. (APB)


Advantages of the spectrographic method as applied to the analysis of dust settled or collected from air and to the direct analysis of the air mixture are discussed. It is pointed out that spectrographic methods are useful for the rapid determination of about 70 chemical elements in dusts, furnaces, air, and animal and plant ashes. The elements that are not readily determined are the gases, halogens, and metalloids, including sulfur. Its inherently high sensitivity makes the method useful for special problems in air contamination involving metallic elements, free or combined. Direct analysis of air has been made for lead, and this method may possibly be extended to the direct determination of other elements. For additional material on spectrographic methods, reference should be made to the extensive literature on the subject. (11 refs. cited)


Problems connected with two classes of smoke—those from industrial boilers and furnaces of various types, and those of domestic origin, almost entirely from the open coal fire—were investigated separately and at different times. The methods of measurement that were finally developed were the same and close correlation among all the results was found. (APB)


Claim 1: Suction-type sampling device for flue gases in flue-gas testers, characterized in that a Sprengel-type pump in which a quantity of the operating liquid is continuously circulated from the lower to the upper container by a circulating pump operating in a closed circuit sealed off from the external atmosphere, is employed to extract the sample of flue gases to be tested from the body thereof, the sample being delivered into the lower container of the Sprengel type pump by the fall tube thereof. (APB)


The internal stability of an aerosol is largely determined by coagulation and gravity settling. The coagulation rate is roughly independent of particle size and shape, and the collision efficiency is in general 100 percent. Gravity settling is only slightly influenced by particle shape except for loose aggregates of low density. The analysis of gravity settling in a convection free and in a uniformly mixed aerosol may be used to measure particle concentration, size, and size distribution.

The light-scattering properties of aerosols provide a convenient measure of particle size and concentration. Accurate measurements may be made when the particles are nearly uniform in size, transparent, and spherical. Nonuniform-size aerosols are analyzed by combination of optical and gravity settling methods. Recently available mathematical tables may be used to analyze certain types of absorbing particles. Optical methods yield approximate and useful results when applied to aerosols composed of irregularly shaped aggregates.


Two types of automatic analyzers to record the sulfur dioxide content of the atmosphere in the range from 0.01 p.p.m. to 1–10 p.p.m. or more are described. One machine draws an air stream at a definite rate for a fixed time through a measured volume of water containing hydrogen peroxide. The latter converts the absorbed sulfur dioxide to sulfuric acid, the conductivity of which is recorded continuously giving both long and short time average-concentration values. The other machine is a continuous countercurrent flow type that records the concentration "instantaneously" and also averages the data over definite periods of time.

Many modifications of the machines have been made for special purposes. The following gases have been determined satisfactorily in the concentration range of sulfur dioxide: Hydrogen sulfide, mercaptans, mustard gas, other organic sulfur compounds, organic
chlorine, and phosphorus compounds; also sulfuric acid aerosols. Finally an analyzer for determining hydrogen fluoride in the presence of sulfur dioxide is under construction.


In sampling air for measuring atmospheric pollution, activated carbon has the advantage since at one sampling it can collect from the air a variety of contaminating substances. It will adsorb petroleum and hydrocarbon vapors, the odorous products of decomposition and putrefaction, and most of the contaminating gases liberated from industrial and chemical processes. Moreover, the adsorptive capacity, efficiency, and retentive power of the carbon for widely varied substances, are predictable.

The collecting unit described consists of two perforated canisters filled with activated carbon through which air is drawn by a motor-driven air blower. The sampling rate is 40 cu. ft. per minute, and the air is drawn over the granulated carbon at a linear speed of 25 feet per minute. The characteristics of a suitable gas adsorption carbon are specified.

After sampling, the canisters are sealed and returned to the laboratory for the extraction of absorbed impurities. Analytical methods and procedures are described in detail.

Suitable activated carbon has a high adsorption efficiency. Tests made with the apparatus described, with 5 organic vapors and sulfur dioxide, gave efficiencies of 93.5 to 99.5 percent. (10 refs. cited) (BH)


Investigations in cloud physics indicated the need for an instrument to detect and measure certain types of aerosol particles. When a gas containing a suspension of vaporizable particles is rapidly drawn past a small, electrically heated filament, a cooling effect is produced by the sudden evaporation of each aerosol particle that collides with the filament. The resultant cooling of a portion of the filament produces a momentary lowering of its electrical resistance, which is a function of the heat required for vaporization of the particle. This change of resistance produced by the particle can readily be transformed into a voltage pulse. By using electrical techniques, the voltage pulses can be counted and analyzed to give information concerning the concentration of particles, particle size, and the mass concentration of the dispersed substance. (AIHOM)


The extremely small concentrations of sulfur dioxide and hydrogen sulfide in polluted atmospheres place very stringent requirements on instrumentation designed for the qualitative analysis of these pollutants. An instrument called the Titilog operates on a novel principle that permits it to analyze for sulfur compounds present at these low concentrations. It operates by automatically titrating the polluted air sample with electrolytically generated bromine. Recent experiments indicate that this instrument can be made reliable in its operation in the range of concentrations encountered in polluted air. It also appears that a single instrument can record the individual concentrations of sulfur dioxide and hydrogen sulfide when both are present as pollutants.


The fluorometric method of analysis presents a new tool to the analytical chemist for the determination of trace materials. In many cases, the reagents used are highly specific and separation is unnecessary. The method involves the irradiation of the material with ultraviolet light and the observation or measurement of the visible light produced. In the analysis of metallic ions organic reagents are generally used, which form chelate compounds with the metals. Many organic substances can be determined directly by the nature and amount of fluorescence produced. Organic materials that do not fluoresce themselves may be carried through oxidation or other suitable reactions to produce fluorescing compounds. In some cases non-fluorescing solvents may be identified by adding fluorescing dyes, which have selective solubilities.

The apparatus used may be extremely simple and inexpensive. Observations may be made under ordinary laboratory conditions with the use of a visual comparator. Photometric fluorometers of several manufacturers are quite suitable for quantitative measurements.

Applications of the reagents used for the sensitivity are as follows: Aluminum with 2.2% dihydroxyazoxanaphthalene-4 sulfonic acid, 0.2 microgram, 1 part in 10 million; aluminum with morin, 0.0005 microgram; beryllium with 1.4 dihydroxy-anthraquinone, 1 microgram, 1 part in 40 million; thallium as a chloride with sodium chloride, 1 part in 50 million; boron with benzoin, 0.2 microgram, 1 part in 10 million; iodine with fluorescein, 2.0 micrometers; zinc with benzoin, 10 micrograms, 1 part in 1 million.

Aromatic hydrocarbons in benzene may be determined by adding a fluorescent dye, which is soluble in these compounds, and absorbing on silica gel. Many biological substances, such as riboflavin, esterone, porphyrins, coumarins, chlorophyll, etc., may be determined by fluorometric methods.


Natural radioactivity in the atmosphere is used as a tracer in the study of aerosol particle-size distribution in the submicroscopic range. Particulate matter is collected by a device that first ionizes the particles and then separates them according to their mobilities. The results indicate that most of the natural radioactivity of the atmosphere attaches itself to particles having diameters in the range 0.001 to 0.04. A predominant grouping of the activity occurs in the vicinity of two particles, diameters 0.009 and 0.018. The relationship between the distribution of radioactivity and the abundance of particles in different size ranges is discussed. (APB)


The basis of infrared analysis and its application are discussed. The three main uses of infrared in research and analysis are fingerprint identification of unknowns, quantitative analysis, and qualitative organic analysis.

Two types of analyzers—the infrared spectrometer and the nondispersion or infrared gas analyzer—are discussed.
Comparison of the possibilities of the two methods is
difficult; however, it is suggested that there will always
be instances in which one instrument will be superior
to the other.

1747. Yoe, J. H. A Proposed Outline for Investigating
and Developing a New Colorimetric Method Employ-
ing an Organic Reagent; chap. in Air Pollution,
at U. S. Tech. Conf. on Air Pollution, Analytical
Methods and Properties Panel, Washington, D. C.,
May 3–5, 1950.

About 2,000 years ago Pliny developed a test for iron
in vinegar, utilizing the first chemical reagent on record.
This oldest recorded test for a chemical element in-
volved the use of an organic reagent (gallnut) sup-
ported by an organic substance (papyrus). The an-
cient Greeks and Romans detected the presence of
alkali in natural waters by its decoloration of red wine.
Thus we see organic reagents were used in making
colorimetric analyses centuries before chemistry devel-
oped into a science. Unfortunately, however, com-
paratively few chemists have realized the advantages
and possibilities of organic compounds not only as col-
orimetric reagents but also in gravimetric and nephelo-
metric analysis. The vast number and great variety
of organic compounds offer one of the most promising
sources for new and better colorimetric reagents, ones
that are specific or selective, and highly sensitive.

The problems involved in a thorough investigation
of a new colorimetric reaction are outlined and some
of the more recently developed colorimetric methods
employing organic reagents used as examples. It is
emphasized that much experimental work is still needed
to establish a better knowledge of the relationships
between the molecular structures of organic compounds
and their reactions with inorganic ions. When a new
reaction is discovered that looks promising from the
standpoint of colorimetric analysis, it is necessary to
make a thorough investigation. The following outline
is proposed: A. The reagent: (1) Most suitable sol-
vent, (2) solubility, (3) stability (in solution). B.
The Color Reaction: (1) Effect of pH, (2) stability
of colored compound to light, (3) nature of color reac-
tions, (4) rate of color formation, (5) conformity to
the Lambert-Beer Law, (6) sensitivity of color reaction,
(7) optimum concentration range, (8) effect of tem-
perature on the color reaction over the range 150°–35°
C., (9) effect of foreign ions upon the color reaction
and upon its sensitivity, (10) best conditions for the
analytical use of the color reaction, (11) application
of the reagent to the analysis of a variety of standard
samples.
CONTROL OF AIR POLLUTION

GENERAL MEASURES

1840


Conditions requiring attention are stated to be the amount and quality of air admitted and its diffusion, time required for this diffusion, and the place at which it occurs. Smoke consumption is considered an impossible means. (MIR—Bib.)

1842


Considers true test to consist in ascertaining the quantity of heat produced rather than the steam generated. (MIR—Bib.)

1843


Abstract, referring particularly to Williams' methods and his Argand furnaces. (MIR—Bib.)


Abstract, giving summary description of Argand furnace invented by C. W. Williams. (MIR—Bib.)

1853


Answers in the affirmative and outlines the advances made in various parts of Great Britain. (MIR—Bib.)

1854


1855


Considers dimensions of furnace to be fundamental consideration and discusses consumption of smoke after formation. Criticizes views of C. W. Williams. (MIR—Bib.)

1856


Criticizes statements in Mechanics' Magazine. Production of smoke has no relation to insufficient boiler surface, and the remedy for the smoke nuisance lies in proper air admission. (MIR—Bib.)

1876


1882


Considers preventive methods in general, with some attention to mechanical methods. (MIR—Bib.)


Report based on Exhibition of Smoke-Preventing Appliances, 1882, at South Kensington. (MIR—Bib.)

1883


Reference is made to the prohibition in 1306 by the King, at the request of Parliament, of the combustion of bituminous coal in London. The smoke of this fuel remained so unsubdued a nuisance that, after the lapse of 54 centuries, an International Smoke Abatement Exhibition was held at South Kensington.

A large number of appliances, mostly grates and stoves, were exhibited. The methods by which their inventors sought to perfect combustion were outlined. Chemical tests made of the effluent gases from the stoves and grates were discussed briefly.

Although the success attained was only partial, the tests offered a foundation upon which to build. More vigorous action in the future should be crowned with success. Chemical information of much interest was gained.


Touchees generally on the cause of the smoke evil and the probability of its abatement. (MIR—Bib.)


Notes, with brief bibliographies. (MIR—Bib.)


Reviews proceedings of meetings in London to consider steps toward reduction of smoke nuisance. (MIR—Bib.)

1764. SATURDAY REVIEW. Smoke Abatement. Vol. 55, 1886, pp. 174-175.

Editorial, discussing suggestions in connection with recent smoke-abatement exhibitions. (MIR—Bib.)

1885


Considers hygienic, moral, and economic aspects of smoke abatement, and methods and prospects of improvement. (MIR—Bib.)


Gives facts as to smokeless equipment used at author's home and manufacturing plant. (MIR—Bib.)

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The following is a condensation of parts VI, VII, and IX of the report:

VI. Requirements for a successful smoke consumer:
1. Efficiency; (a) Development of high temperature; (b) regularity of action; (c) not easily got out of order; (d) small increase to operation. (2) Capacity: Must be efficient when boiler is working to full capacity. (3) General applicability; (a) Ready adjustment; (b) application in limited space; (c) low cost; (d) few repairs; (e) no injury to boilers.

VII. Classification of the important types of smoke-preventing devices already proposed and the principles on which they depend.
1. Steam power to introduce air into the fireplace. (2) Firebrick arches or chokerwork. (3) Hollow walls for preheating the air. (4) Coking arches or chambers. (5) Double combustion. (6) Down-draft furnaces. (7) Automatic stokers.

IX. Conclusions and recommendations: These deal with (1) a determination of the practical limits within which smoke emission may be confined, and (2) a determination of the applicability of various devices to the purpose intended. Recommendations are as to legislation and the diffusion among the public of information as to the facts which may aid them in using smokeless fuel. Various circulars and ordinances in Cincinnati and Pittsburgh are cited.


Patent apparatus for purification of gaseous fumes, air, etc. An ordinary exhaust fan, into the casing of which numerous nozzles are fitted. Water, containing substances in solution, is made to impinge on the vanes of the revolving fan, and is converted into mist and takes out all solid particles.

1893


Does not consider individual devices but gives broadly the evils of smoke and the principles of smokeless combustion. Gives ordinances of several cities.

1895


Considers very briefly the good and bad features of a large number of devices. Believes that smoke production can be decreased, but that total suppression is impracticable.


History of attempts at smoke abatement, especially in Scotland; also discussion of methods of firing with results of many tests.

1896


Editorial, taking the position that smokeless combustion is practicable and dependent merely upon proper design and operation of equipment.


The subject is considered from a chemical and from a mechanical standpoint.
Conclusion of the preceding discussion. The smoke nuisance in various cities is referred to by those taking part in the discussion and some of the methods of control are mentioned. The development of several furnaces, such as Bunsen's and Siemens', are described briefly.

The discussion was closed with the statement that "now that the principles of smokeless combustion of bituminous coal are so well understood and are capable of application to all stationary boilers is no reason for the encouragement of the growth of a smoke nuisance in this city by failure to provide suitable restrictions or regulations." A resolution was passed to the effect that continuous or frequent discharge of dense black smoke should not be permitted within the city limits.

An appendix gives the smoke ordinances of Chicago, Cincinnati, Cleveland, Pittsburgh, State of Ohio, St. Louis, Detroit, Milwaukee, and Minneapolis, and an ordinance submitted to the Councils of Philadelphia in 1894, on which no action was taken.

1898


Editorial on the British agitation concerning smoke abatement. (MIR-Bib.)


Brief survey of the character and composition of fuels, the principles of combustion, and the conditions that favor their completeness. (MIR—Bib.)


General statement of attitude of authorities toward smoke production. (MIR—Bib.)

1899


Output of coal in the United Kingdom, 202 million tons. Smoke nuisance treated from two points of view: (1) Scientific investigations of chimney smoke; (2) various remedies applied. Root of smoke evil the raw coal burned, and full fruition insured by the method of burning. Total coal consumed during 1888 in the United Kingdom, 150 million tons, including: (a) for power: 81 for heat (46 industrial and 55 domestic). For power, railways, 10 to 12; coast steamers, 6 to 8; mines, 10 to 11; factories, 38 to 40. For heat, blast furnaces, 10 to 18; steel and iron works, 10 to 12; other metallurgy, 1 to 2; chemical, pottery, glass, etc., 4 to 6; gas, 13 to 14. From observations of the exhaust of locomotives, it is thought that steam with the smoke causes rapid deposit of soot. Vegetation along the lines is injured, also by steamboats in narrow rivers, but of course not in coastwise trade. In factories, the classification ought to be: (1) Hopelessly smoky and (2) potentially smokeless. The contractors' vertical boiler, the egg-ended boiler of the small city factory, and the multitubular boiler for electric lighting, derived from extinct threshing machines, are of the first class; the Lancashire boiler of the second. Generation of electricity by steam produces dense black smoke, an anomaly in an apparatus designed to insure purity of light and air. In 1896 the Glasgow and West of Scotland Smoke Abatement Association issued a report on firing Lancashire boilers by hand and by mechanical stokers. The conclusion was, that means were now known to enable one to work heavily with smoke. In 1898 the Manchester Committee for Testing Smoke-Prevention Apparatus (the outcome of a suggestion made by the chief inspector under the Alkali Acts, etc.) concluded
that a manufacturing district may be freed of smoke (at least from steam boilers) by carrying out the suggestions in their report.

Remedies: First, mechanical aids to combustion; second, manufacture of smokeless fuels.


This article is a general discussion of the smoke situation, particularly in the larger cities of England. The author states, "That to put pressure on the owners of chimney pots to burn their own black smoke, or rather not to allow them to produce it, is the difficult question which is actively occupying the public mind."

Domestic fires and restaurant chimney tops were the source of the larger portion of the black smoke nuisance.


Adoption of Hawley downdraft furnace solved question in one plant.


Gives reasons for smoke and describes author's patent furnaces as applied to water-tube boilers. (MIR—Bib.)


1900


Considers conditions of successful smoke abatement and the devices in most general use. (MIR—Bib.)

1901


Steps taken to abate smoke in Cleveland are reviewed.

Gives a brief résumé of the activities and accomplishments of smoke abatement in Cleveland. A prediction is made that forces at work will effect a considerable revolution in smoke control in the next 2 or 3 years.


General explanation of cause of smoke and means for prevention. (MIR—Bib.)


Reference is made to smoke pessimists. While it is agreed that the time must come when power will be derived from gas producers and gas engines, no reason whatever is seen for smoke to be produced even where coal is burned under boilers. Soft coal can be burned "out of sight," that is to say, away from the cities—but it seems that where much coal is being burned in the process of producing electrical energy for use in the smokeless city, another city will rise.


Mainly a synopsis of the conditions of combustion. In the design of appliances for smoke prevention, the problems of air admission and admixture of gases have been fairly well solved but failure results through lack of proper temperature. (MIR—Bib.)


The chemistry of complete and incomplete combustion is given at length. Various furnaces and best methods for hand firing are discussed. Devices for hearing and distributing air above and beyond the fire bed are described, as well as steam jets for mixing combustible gases with the air supply, double furnaces, down-draft furnaces, and underfeed furnaces. (MIR—Bib.)


The general use of soft coal which has been an accompaniment of the coal strike has given a number of cities, particularly New York, a faint but very unwelcome illustration of conditions that constantly prevail in Pittsburgh, Cleveland, Chicago, and other cities where soft coal and clouds of dense smoke are the rule. There is no smoke nuisance where anthracite is universally used, and it is reasonable to expect that, in New York and other cities supplied from the anthracite regions, the smoke will vanish when the strife between the coal operators and miners is settled; but there is danger that soft coal, having been introduced far more extensively than heretofore, will be continued in use by many consumers in the northeastern cities indicated, while it is of course certain that its consumption elsewhere will increase with population and industry.

Heretofore some of the large soft-coal-using manufacturing cities have prided themselves on the volume and density of their smoke and have resented efforts to lessen it, urging that smoke and noise, however needless they may be, are profitable advertisements of great manufacturing centers. Fortunately, other ideals of municipal greatness are now being adopted; and Cleveland, St. Louis, and several other western cities are seriously grappling with the smoke evil. If hard coal, coke, oil, or some other smokeless fuel were everywhere available at as low a price as soft coal, or if it was impossible to burn soft coal without creating an intolerable nuisance, the use of the latter fuel, within specified districts, might be prohibited; but in the absence of the conditions named such prohibition would be impracticable and unjust.


Results of tests made with the Wilson process of injecting into the furnace a very minute quantity of
nitrate of soda in solution, in combination with sufficient air to produce perfect combustion of the gases. (MIR—Bib.)


It is stated that the only way to burn soft coal continuously without smoke is to burn it somewhere else, far away where you don't see it. Electricity and gas are favored. It is suggested that "if we can't stop the making of smoke we can stop the burning of coal in cities and that is the thing to steer for."

1903


General review of principles and methods of smoke prevention. (MIR—Bib.)


Gives steps for prevention of smoke evil. Metallurgical and domestic smoke are considered especially. (MIR—Bib.)


King Edward I appointed the first smoke commission; provided punishment by fine for first offense maintenance of smoke nuisance—destruction of furnaces if smoke was not suppressed. Later, in 1306, the use of bituminous coal was prohibited in London, by proclamation of the King, and the making of smoke was made a capital offense. A man was hanged in London for burning soft coal.

Smoke repression, or suppression, cannot be obtained in any city in a week, month, or year—unless the heroic power of public sentiment and law shall sacrifice the material interests of many business men, taxpayers, who have, in part, aided in the making of the city that is represented by present material development. Time, patience, proper consideration for material investments, and physical conditions, education on economic lines, and proper supervisory power for new plants to be erected will solve the problem satisfactorily; in other words, industrial progress and the self-interest of those who produce power will repress smoke to the lowest possible limit.

1904


Considers use of smokeless fuels, furnaces causing little smoke, and automatic stokers. (MIR—Bib.)


Takes position that smoke cannot be eliminated, but that its evils can be diminished. Shows that mechanical stokers do not necessarily promote efficiency. (MIR—Bib.)


General presentation of the extent to which cities may be freed from smoke and of methods of procedure. (MIR—Bib.)

1905


Brief general article, considering bituminous coal as a smoke producer, and methods of smoke prevention. (MIR—Bib.)


Coal consumers and the public have an interest in smoke prevention. When a chimney smokes constantly and seriously, coal is being wasted, and the owner of the plant incurs a regular loss by the waste. At the same time the public is inconvenienced and injured by the smoke and suffers extensive damage, pecuniary and other, from depreciation of property, injury to the general health, increased cost of painting buildings, extra cleaning, etc.

The following four classes of successful devices for smoke abatement are presented and explained: (1) Steam in jets; (2) furnaces; (3) mechanical stokers; (4) smokeless coal.

In Cleveland the campaign for smoke abatement was one of education solely, and the results attained there were due entirely to a desire to save money. In Chicago the campaign was one of prosecution. Both, however, are notable examples of clean cities in the soft-coal district.

1906


Attempts at smoke abatement are as old as the art of burning fuel itself. Three methods of reducing smoke are: (1) Closing down smoke-making plants; (2) use of smokeless fuels; (3) burning ordinary fuels smokelessly.

If the furnace, however, is not well designed or is overworked, no amount of skill or care will keep the smoke within bounds. In such cases resort must be had to special apparatus. Successful processes may be divided into the following classes: (1) Steam jets; (2) coking furnaces or firebrick arches; (3) down-draft furnaces; (4) automatic stokers; (5) powdered fuels.


Deals with grate and furnace design, intelligence in the boiler room, and scientific methods of hand firing. (MIR—Bib.)


Abstract of a discussion before the Society of Chemical Industry. (Does not appear in its Journal.) (MIR—Bib.)


The society was formed in 1890 to determine the nature and extent of atmospheric impairments arising from coal smoke; to consider the question of coal consumption in boilers, furnaces, and domestic fireplaces; to study the present system for controlling the emission of smoke.

It was found that half a ton of soot fell on Leeds each day. An average of 5 percent of soot in all the coal burned is the amount calculated for the air in Leeds.

As the best mode of treating the problem the society resolved to press for extension of the Alkali Act bringing the chimneys of all works under the same kind of control and to memorialize the local government board for the appointment of Government inspectors and to join forces with the Manchester Smoke Abatement League and the Sheffield Smoke Abatement Society. The local government board refused to receive either the deputation or the memorial.


An account is given of the work of the Hamburg Smoke-Abatement Society. This is a volunteer organi-
zation of steam users, bound together by the common desire to obtain greater efficiency and less smoke from their steam-raising plants. The organization and operation of the Society are discussed. Expert members of the staff of the Society examine the plants of members and make suggestions for improvements. Education and control of firemen in the execution of their duties are undertaken by firemen-instructors on the staff of the society. The Hamburg society is showing manufacturers how to combine to attack the smoke evil at its source.


The literature on fuel engineering shows that there is no necessity for the emission of appreciable smoke from the stacks of stationary boilers. Measures for preventing smoke are cited. A radical improvement suggested is the compulsory use of hard coal within the city limits.

1907


Considers the reduction of smoke from five sources: Large furnace fires, large boiler plants, small boiler plants, domestic fires, and locomotive fires. (MIR—Bib.)


Discusses principles of smokeless combustion, practical methods for smoke prevention, and methods employed by Hamburg Smoke Abatement Society. Concludes that with properly designed plant and properly trained firemen smokeless combustion is assured. (MIR—Bib.)


Discusses the different sources from which smoke is produced and discusses smoke ordinances and their administration in different localities. (MIR—Bib.)


Reviews remarkable progress in abatement of smoke during past 5 years. (MIR—Bib.)

1928


Discusses briefly the proximate causes of smoke evil, efficient methods of abatement, and ethical and legal questions involved. (MIR—Bib.)


Shows that horizontal fire-tube boiler is not adapted for smokeless combustion of Illinois coal. Considers efficient hand firing, preparation of coal, etc. (MIR—Bib.)


Editorial, reviewing discussions and recommendations of Committee of Syracuse (N. Y.) Chamber of Commerce. (MIR—Bib.)

1928


The smoky atmosphere of London is compared with the brightness and freshness of the atmosphere of such continental cities as Paris, Vienna, and Berlin, which their immunity from smoke confers on their social and industrial life. Considerations of health, convenience, and economy point to the need for some improvement in the atmosphere of London and other great British manufacturing cities. It has been reported that, of the 150 million tons of fuel used annually in England for heating purposes, fully 50 million tons is wasted owing to insanitary methods of use.

Extracts of regulations respecting the laws and recommendations for preventing smoke emission in France, Germany, and Austria are cited, as well as the work of the Hamburg Society for the Abatement of Smoke and Promotion of Fuel Economy.

Practical suggestions for combating the smoke nuisance in England are included.


This is a review of the subject of smoke abatement which should be of practical interest to those in charge of power plants that are located in or near large villages or cities.

The nature of the chemical actions that take place in a boiler furnace during the process of combustion and the importance of firing and furnace construction as affecting the formation of smoke or prevention of smoke are discussed.


Editorial review of smoke-prevention work in various cities. (MIR—Bib.)

1939


Explains principles of smokeless combustion, shows the Engelmann scheme for estimating relative density of smoke, and describes types of furnaces and boilers. (MIR—Bib.)


Briefly reviews lines of work carried on by the Technologic Branch of the Geological Survey. Describes investigations regarding utilization of low-grade fuels, waste of central heating plants, etc. (MIR—Bib.)


Explains cause of smoke and principles of smokeless combustion, describes devices for use with hand-fired furnaces and mechanical apparatus for boiler firing. (MIR—Bib.)


Discussion of rules laid down by the Magdeburger Verein für Dampfkesselbetrieb. (MIR—Bib.)

1910


Analyzes the causes which permit formation of smoke. Describes and illustrates furnace, stoker, and boiler arrangements for smoke prevention. (MIR—Bib.)


Reviews reports for 1909 of the London Coal Smoke Abatement Society and of the Hamburg Verein für Feuerungsbetrieb und Rauchbekämpfung. (MIR—Bib.)

The following points are made: In localities using bituminous coal, high in volatile matter, smoke can be prevented only by installing specially designed furnaces. Even under these conditions, skill and care in firing are highly important. Properly designed automatic stokers are superior to hand firing, both in reducing smoke and in economy. (MIR-Bib.)

1911


Reviews work accomplished and methods successfully used. Ringelmann charts were used in establishing density of smoke. (MIR-Bib.)


Includes brief historical review. Describes and discusses best practice. (MIR-Bib.)


Review of progress in 6 months under new State law (1911). (MIR-Bib.)


Much attention is given to instructions to firemen. Unique feature of law is its classification of stacks according to their inside diameters. (MIR-Bib.)


It is possible to fix a sound and workable standard for smoke emission, and to apply it in a practical way.


Concise summary of the evils of smoke, extent of the nuisance in New York City, and present (1911) status of smoke prevention. (MIR-Bib.)

1912


Good annual summary of progress in smoke abatement. (MIR-Bib.)


Faulty furnace construction and improper charging methods are considered as causes of smoke, and method of determining atmospheric pollution and operation of automatic smoke recorder are described. (MIR-Bib.)


Scientific sermon, in which the doctrine of fuel economy is preached.


The question "Can smoke be prevented?" is answered by the statement that many factories, mills, and power plants are being operated actively without the production of an appreciable amount of smoke.

The experience of one of the largest milling companies in the world is cited as an example. The coal consumption amounts to about 50 tons for 24 hours. The variety used is a good grade of bituminous coal. According to the engineer, there is no smoke.

Combustion requirements of fuel and methods of smokeless operation of fuel-burning devices are discussed.


The smoke nuisance is caused by careless and inefficient use of fuel (particularly coal) not only by industrial concerns but also in domestic fireplaces.

The volatile constituents of fuel and their utilization are discussed. Methods of firing recommended are "ribbon firing" with hand firing, "alternate firing," "cooking," and the use of the mechanical stoker. It is hoped that the march of public opinion as regards smoke abatement may be such that it will be considered as blameworthy to emit smoke from a chimney as it now is to allow drinking water to be contaminated by sewage.


The effective control of smoke fume has been a problem for years, commanding the attention of metallurgical engineers. Except for sulfur dioxide, the various constituents of the fume have been controlled, but this volatile vapor has continued to defeat all attempts to prevent its escape. The pollution carried by the smoke has yielded to mechanical means, such as the laghouse and electrical contrivances, but it has been shown conclusively that mechanical devices are unable to handle sulfur dioxide gas, and as this element is one of the principal sources of damage to vegetation, the importance of its control is appreciated by all familiar with the subject.

In the thiolene process it is proposed not only to control the noxious gas but to make the detrimental factor become an asset. In smelting, each 1,000 tons of pyrite ore discharges approximately 800 tons of sulfur and oxygen into the atmosphere, and by employing a reducing agent to combine with the oxygen it is planned to recover the sulfur and convert it into a valuable article of commerce. It has long been known that, by uniting carbon with the sulfur fume and passing the product over limestone containing iron salts, the gas is decomposed and sulfur precipitated. In the thiolene system an oil spray is used to supply the carbon, and calcium sulfide forms the suitable accelerating agent. Calcium is preferred to potassium and other alkaline sulfides because of its lower cost and high insusceptibility. It has been found desirable to clean the gas as thoroughly as possible and to concentrate it before it is permitted to enter the combustion chamber. The costs attending operation of a plant of this nature are expected to be largely counterbalanced by the revenue derived from the sale of sulfur.

The thiolene process marks a new and forward step. It aims not only at the extinction of noxious gases, but also endeavors to raise the detrimental elements to the dignity of a byproduct.


Mainly condensed report of meeting of American Society of Mechanical Engineers, Oct. 8, 1912. (MIR-Bib.)


Discusses conditions at boiler plants in the United States, the smoke ordinance of various cities, the factors that cause smoke, and the methods of smoke abatement.

1913


General discussion. The study of legislation referred to that carried on at the University of Pittsburgh. (MIR-Bib.)
Experiments in the control of fumes at a Herault smelter in California are described. The results were satisfactory enough to indicate possible control of the fumes which brought the California copper industry to the verge of ruin. Control of sulfur dioxide had become the question of the hour in the California copper fields; as most of the smelters had been closed because of damage caused by the fume.

The inventor of the method of control claimed that by employing the hydraulic suction draft instead of the forced draft by stacks, the volume of gases was cut down fully four-fifths, while the capacity of the furnace was augmented one-third. The process had not been demonstrated as a complete practical success but was successful enough to command the interest of engineers familiar with the tests.


General consideration of methods of smoke prevention and their relative merits. (MIR—Bib.)

1915

Suits have originated in many States, including Utah, Tennessee, and California, because of damage claimed to have resulted from the fumes from smelters, commonly referred to as smelter smoke. Various processes are mentioned for overcoming or decreasing the ground slag or slag wool, dilution of the sulfur dioxide by air, as well as bringing the gases containing sulfur dioxide into intimate contact with lime in the presence of water. Considerable friction is still caused by smelter smoke between the metallurgical and agricultural industries in certain parts of the country, which indicates the opportunity of high-class technical invention directed to the subject. A few years ago a committee consisting of Dr. Joseph A. Holmes, Director of the Federal Bureau of Mines, E. C. Franklin of Stanford University, and Ralph A. Gould, a chemical engineer of San Francisco, was appointed to investigate and decide future questions of annoyance and nuisance resulting from the escape of smelter fumes and its report, submitted November 1914, is to be published as soon as practicable.

1916

Discussion is presented on what Pittsburgh has done toward accomplishing smoke prevention during the past two years and a half.
The policies and methods of carrying out a smoke-prevention program are outlined.

Solution for elimination of railroad smoke lies, first, in scientific designing of boiler and firebox, combined with a most efficient design of valves and cylinders, so as to produce the greatest possible economy of coal and water; and second, in skillful firing and running of the locomotive which can only be accomplished by careful selection of men, through instruction and efficient supervision.

In order to carry out an effective smoke abatement program there must be engineering progress and public support. The following points are covered: (1) Causes of smoke; (2) responsibility for smoke; (3) prevention of smoke; (4) stokers (chain gate, overfeed, and underfeed); (5) air supply.

1917

A great deal has been done in the abatement of smoke by the adoption of smoke-prevention appliances in connection with factory furnaces in the towns of Lancashire and Yorkshire. The smoke nuisance is due chiefly to the fireman allowing too long intervals between the firings. This leads to too much coal being put on at one firing, and the issue of black smoke; but a deficient air draft, often due to a small cramped flue in a low chimney, may also be a cause.

1921

Smoke prevention is a campaign of education in all angles of the boiler room from construction of the boiler, the erection of the boiler, and the operation.
To combat successfully the smoke evil furnaces should be constructed so that they will burn any kind of fuel.

Objectionable smoke and cinders in large plants can be eliminated. In the smaller, high-pressure plants railroad terminals can be electrified; but domestic furnaces are a problem yet to be solved.
The problem of smoke as it exists is outlined.

The use of coke as a means of eliminating the smoke nuisance is discussed. In this connection a brief history of coke making is presented.

The necessity of bringing about cooperation, education, and standardization for preventing railroad smoke is reviewed in detail.

1923

The chief function of the brick arch in abating smoke is that of a gas mixer. By baffling and compelling all of the gases to pass through a relatively restricted area above the arch, an intimate mixture of the volatile combustible with the oxygen is insured. While the mixing of the gases at the end of the arch does not take place soon enough to eliminate smoke entirely, it has the effect of reducing the smoke emissions.
Tests that were conducted are quoted.

The object of the Smoke Prevention Association is to reduce the smoke nuisance in cities. The Association can function either by standing as an active antagonist of smoke producers or as a friendly cooperating body that works with fuel users to reduce the smoke nuisance. It is understood that from its inception the Association has adopted the cooperative policy.
The various papers presented at this convention indicate that the combustion engineer today realizes that smoke abatement must be based primarily on proper furnace design, construction, and equipment, and that...
the human element only becomes a factor when engineering skill has placed under the control of the fireman a plant that can be operated without the waste of fuel as indicated by smoke at the stack. The problem of smoke prevention is largely centered in the ability of the association to make friends of the little fellows and carry through the message of good will that makes community life worth living.

Both the railroads and the cities are included in the discussions of the smoke problem.


A discussion is presented on the satisfactory results of smokeless combustion obtained from the use of cast-iron boilers.


Some of the modern developments in equipment that produce power smokelessly are considered. Some of the developments discussed are the use of powdered coal, gas-filled cars for railway roads, railroad equipment and hydroelectric power.

In connection with hydroelectric power mention is made of a superspeed proposition, almost inconceivable in vastness, yet comprehensible and practicable, where the energy from present plants and future installations will be merged into one great system.

The developments mentioned are matters for consideration as timely and interesting but not all of them possible of immediate realization. The Association should turn its activities toward education and recommendation and practical demonstration show how not to make smoke; it must interest fuel users and assist them in burning the fuels at hand smokelessly.


The following points are covered:
1. The deleterious effects of smoke;
2. Methods of treatment;
(a) Cleanse smoke by washing; electric precipitation; removal of plants outside city limits; central power and heating plants; smoke drains; other methods;
(b) Raw coal;
(c) Powdered coal.

Reference is made to the bibliography of 1,500 books, bulletins, and articles published by Mellon Institute on Combustion as It Relates to Smoke Abatement. Most authorities, except the English, agree that it is possible under certain maintained conditions to burn high volatile coal without production of smoke. They further agree that in many instances where proper conditions and equipment are at hand conducive to smokeless combustion the human element does not "conduce" but produce and smoke is the product.

Some of the major effects of smoke are discussed from the health as well as from the economic viewpoint. Remedial and preventive methods are discussed.

Some of the remedial methods mentioned are cleansing smoke by washing, electric precipitation, removal of plants outside city limits, central power and heating plants under rigid restrictions and supervision, and smoke drains. That is, tall chimneys admitting the smoke at sufficient height to carry it beyond thickly populated districts.

Preventive measures are used of gas, electricity, coke, anthracite, oil or carbonized coal, peat, or lignite as fuel. The best fireman can take the poorest grade of fuel and make less smoke than the careless or unintelligent fireman can do with the best coal and equipped with every possible device for aiding perfect combustion. Advantages and disadvantages in the use of powered coal are outlined.


The ups and downs experienced by various women's organizations over a period of 30 years in Minneapolis are detailed. Periods of enforcement of smoke prevention ordinances were followed by negligence and failure to obey or enforce any regulations.

It is concluded that there should be no lapse in everlasting agitation. It is eternal vigilance that counts. Everything possible should be done to call public attention to the smoke nuisance.


The deleterious effects of smoke are summarized under four headings: Its effects on (1) health; (2) buildings and building material; (3) vegetation; and (4) general municipal cleanliness and beauty.

Various methods of eliminating smoke are discussed. It is expected that the major progress in the future will be made along three lines:
1. Increasing use of gas produced from low-grade coal;
2. Use of low-volatile coal in pulverized form; and
3. Production and utilization of carbonized coal or low-temperature coke from low-grade coal.

1925


Smoke is defined as the gaseous and solid products of combustion, visible and invisible, including mineral and other substances carried into the atmosphere with the products of combustion.

A detailed discussion is presented of standardization of ratings; air regulations; stacks; and automatic feed.


Discusses atmospheric conditions in Grafton, W. Va., with special reference to smoke, and makes recommendations on methods to be employed to reduce smoke to the minimum. It is intended as a guide in campaigns of free communities suffering from smoke-laden atmosphere due to inefficient use of high-volatile coal.


The advantages of the cindervane fan is described; and detailed diagrams are presented.

1925


Discusses all-service gas mask, its construction and use.


Smoke inspectors should insist on smokelessness by the efficient route.

The importance of using the proper apparatus is stressed; and the smoke inspector's duties are outlined.


Experience in smoke abatement covering the past few years is outlined.
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The procedure used by the Pennsylvania Railroad to abate smoke in Pittsburgh is outlined with following points covered:
(1) Fuel, (2) engine house operation building fires, (3) cleaning fires, (4) knocking fires, (5) banking fires, (6) cooperation of the crews, (7) cooperation of officials, (8) power plants, (9) savings. 1926


A discussion is presented of the essential factors that enter into the cooperation that is so vital in order to avoid out a smoke prevention program.


The method of drafting a locomotive with a new type of nozzle that has an exhaust governor is described.


The practical propositions appear to be:

1. Excellent results in smoke reduction follow steady pressure, over a series of years, by a skillful blend of helpful persuasion and application of "ordinances," which in some States even go so far as to specify methods and plant.

2. The initiative invariably has lain with the betterment clubs, and has met with opposition from the manufacturers until the latter have found that smoke-prevention is an economical proposition. Campaigns have been begun by volunteers calling on householders, early in the morning, with offers of instruction in stoking of domestic furnaces—with the result that a 50-percent reduction in smoke ensued. The clubs assist the manufacturers to the utmost extent with advice, plans, and estimates.

3. The proportions of smoke coming from various sources and the amount avoidable are thus given as the average for United States cities:

<table>
<thead>
<tr>
<th>Manufacturing plant</th>
<th>45</th>
<th>95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residences</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>Railways</td>
<td>18</td>
<td>75</td>
</tr>
<tr>
<td>Hotels and buildings</td>
<td>12</td>
<td>60</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>6</td>
<td>50</td>
</tr>
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</table>

4. Railway smoke due to shunting in town stations may be almost abolished by the use of diesel engines for shunting purposes. (BH)


A study made from the standpoint of smoke abatement is described. The various sources of smoke were investigated and possible remedies and recommendations are made for attacking the problem. The investigation extended over the heating season, beginning about October 1 and ending about April 1, and included the following subjects: Location of the city and weather conditions, smoke study, ringelmann chart readings, survey, residence-equipment survey, cooperation of industrial and heating plants with the city, ordinances, and recommendations.


Describes the method advocated by the Bureau of Mines for a smoke-abatement campaign in a city of the size of Salt Lake City.


The cause, effect, and the remedy for smoke is described. Methods by which effective smoke prevention can be accomplished are: (1) Scientific firing in big power plants; (2) extension of electrical and gas energy; (3) electrification or other smokeless system for railroad terminals; (4) use of smokeless fuels for house heating and other domestic purposes; (5) by scientific rate making; (6) education of the fuel user. 1927


This symposium illustrates up-to-date methods: The Society of Medical Officers of Health assembled a M. O. H., by a town councilor, known as the Women Citizens’ Association, and one of the Advisory Committee on Atmospheric Pollution, who discussed the following subjects:

(a) The importance of the appointment, by town councils, of specialist "smoke inspectors" able to teach stokers to locate those apparently trivial defects of flue construction, method, and fuel to which so much smoke is due.

(b) The economy of replacing hand firing of furnaces by machine firing.

(c) A difference of 75 cents of worth of soap and 1 hour of laundry work per week was cited as between Manchester and Harrogate, and the cost of smoke in this country was estimated as 50 cents per head per annum.

Gas was recommended for cooking, and smokeless fuel for other domestic purposes; reference was made to an "all-in" system at Manchester by which electricity is supplied on the basis of a fixed charge (determined by the ratable value of the house occupied) plus 5½ d. per unit for current for all purposes.

(d) The paper on "The Point of View of the Meteorologist" is well worth perusal, on account of its lucid exposition of many interesting physical laws involved in the formation and maintenance of fog and smoke. It stresses the differences between smoke particles with 1 micron diameter and a settlement rate of 0.003 cm. per second, and water droplets of 5 to 20 microns in diameter which produce water-fog.

The effects of air stratification—itself due to a temperature gradient of 1°C. per 100 meters elevation—are ably put, and in too concentrated a form to permit of further condensation. (BH)


A good summary of the prevention of smoke nuisance based largely on the Report of the Committee on Smoke and Noxious Vapor Abatement, London, 1921, which is of interest in view of the coming into force of the Public Health (Smoke-Abatement) Act, 1926, on July 1, 1927. It is estimated that 2½ million tons of smoke are annually poured out to the comparative freedom from smoke pail of the suburbs of many German towns, such as Essen and Krefeld. There is no German national law, but in most towns every person wishing to install a steam engine or furnace must obtain the
approval of the police, who can demand any modifications.

Further, the establishment of any new factory must be approved and the amenities of the locality are considered before such approval is given. Probably the most important factors in getting rid of the smoke poll over German towns consist in: (1) Almost complete absence of domestic smoke; (2) general use of gas in factories, and efforts to obtain the maximum value from fuel in furnaces; (3) the regional planning of towns with allocation of certain areas for industrial development.

In view of the figures given above it is clear that the first is by far the most important. (BII)


The history of the coal industry in the United Kingdom and the various processes of carbonization of coal to obtain gas and electricity are reviewed. The latter review deduces two most important conclusions from the fact that a combustion efficiency of more than 80 per cent (possibility 90 per cent) is obtainable in both furnaces of stoker with raw coal—namely, that (a) the existing average efficiency of only 70 per cent continues smoke, which is even a worse crime than the waste involved, and (b) the prospects of general conversion of the power of coal into electric power recede as the mechanical efficiency of boiler furnaces rises above the 80 per cent level, which makes that direct method of combustion relatively the more economical.

Point and force are given to this latter deduction by the statement that “the overall thermal efficiency of the generation of electricity from coal in the power stations of this country, averages only about 13 percent, that of the best stations rising to 20 percent,” although no by-products of the coal are recovered as by manufacture of gas. Hence, the relative costs per ton are:

| Electric power, 5s.; gas, 1s.; coal, 2/1d.; coke, 1/4d. (approx. ratios, 120, 24, 4, 3) |

The capital charges account for 40 percent of production costs, and the average output of electrical installations in this country is only 27 percent of their capacity, a very great reduction in price would follow a reduction of the “load factor” (that is, the ratio of energy produced to the maximum energy producible), but there is the immediate prospect of its pressure approaching that of either solid, liquid, or gaseous fuels.” At present, only some 4 percent of the home consumption of coal is used in the generation of electricity.

On the other hand, carbonization of coal in closed retorts provides gas, smokeless fuel (coke), and by-products, the last of which pay 50 to 80 percent of the cost of the coal carbonized. The thermal efficiency of the process should reach 80 percent—coke 50, gas 25, and tar 5 percent. An increased heating value can be obtained by using some of the coal to produce water gas (CO and H2), by playing steam upon incandescent coke, the coke being thus reduced and the amount and heating power of the gas increased. Owing to the very high calorific value of H (41/4 times that of C), this innovation meets the needs of industry for gas giving heat rather than light, while introduction of the incandescent gas mantle enables this great heating power to be applied with advantage to lighting also. The disparity between the thermal price of coal and of coke is further reduced by the saving of gas being turned off when not required, by the saving of cleaning and transport charges, and by the facility for applying the heat of a gas flame accurately at the desired area. (BIII)


In St. Louis a large proportion, probably over 90 percent of the people, are interested in the smoke-abatement movement and are willing to cooperate. It is suggested that the league use its educational campaign and demonstration methods for the interested 90 percent and turn the 10 percent, who will not cooperate, over to the city smoke department.


The disadvantages of smoke, to which much attention has already been directed in Britain and America, are reviewed. The effect on health, if it exists at all, has not yet been analyzed with any certainty. Plant life, however, is affected adversely, more particularly in certain families such as the confiers. In Austria and Germany control of the nuisance by legal enactment has been a failure and manufacturers can only be brought into line when they can be made to realize that economies can be effected by smoke prevention. The usual measures of improvement of fuel, furnaces, and similar matters are noted. The dust of streets presents a special problem. The use of water and of hygroscopic wastes from potash and cellulose works is not a complete solution. Treatment with tarry products further research to produce a more perfect road surface is much needed. Attention is drawn to a special defect of town atmospheres—a defect which has possibly a greater influence on the health of town dwellers than is generally realized. This is the presence in the town air of carbon monoxide, derived from the exhaust gases of motor cars. At 30 km. per hour the amount of this gas forms about 5 percent of the exhaust. It is estimated that in Berlin a daily total of 125,000,000 m3 of carbon monoxide is thus belched forth into the atmosphere. These figures indicate the need for continual improvement in engine design. (BII)

1929.


The elimination of black smoke is an issue of prime importance, not only to the coal-burning industries—be it transportation or otherwise—but to the community affected, and also in a large measure the whole economic structure. As in any other undertaking, a thorough knowledge of the job is the prime factor in bringing about results. A smoke inspector, able to demonstrate how to do the job properly, will have no trouble in bringing about the necessary results.


Black smoke issuing from the stack of a plant is a positive indication of unnecessary waste of money. A smoke inspector, who is an educator, should be welcomed by business men because of his willingness to give them expert advice on the smoke problem and preventive measures.


The provisions of the Smoke Ordinance of Detroit (written by engineers and enforcement administered by engineers) are described. Smoke can be prevented by: (1) The use of fuels suited to the equipment; (2) firing carefully and intelligently; (3) selecting proper equipment for the work to be done, and maintaining it properly; (4) use of mechanical stokers and steam air jets; (5) following the advice of the Bureau of Smoke Inspection and Abatement.
AIR POLLUTION—A BIBLIOGRAPHY


The accomplishments of 3 years of the St. Louis Citizens Smoke Abatement League are summarized. The two important phases to smoke abatement are: (1) To educate the people; (2) to let them know there is someone on the job who is likely to check them up at any time.


The following four elements entering into the formation of smoke are discussed: (1) Fuel to be burned; (2) duties to be performed; (3) maintenance of locomotives; (4) education and instruction of men doing the work.

Preventive measures are offered.


The advantages of the direct steaming system adopted at the Riverside Engine Terminal at Cincinnati are described.

After operating for a period of more than a year not only was fuel economy obtained but also there was considerable abatement of smoke.

1930


Smoke is conducive to fog and dangerous to flying. Punitive measures should be taken to abate the smoke nuisance as air travel is on the increase.


Presents a discussion on smoke reduction and smoke elimination through the use of anthracite.


The activities of the Toledo Smoke Abatement League are described.

Interest in the problem is stimulated by meetings held every 90 days to which the public is invited.


A history is given of the smoke-abatement campaign of 1919–20 conducted by the Bureau in cooperation with Salt Lake City and the University of Utah. Smoke from industrial plants has been reduced 90 percent, but residence smoke still constitutes a problem.


The power plant used to supply steam for the Kansas City terminal is described. During nearly 16 years of this power plant’s operation black smoke has never been emitted.

1932


The difficulty of the smoke inspector is to induce people to practice any of the schemes that are put forward and which they know will prevent pollution. A clean atmosphere can be brought about only by the will of the people. Legislation, administration, and smoke inspections are useless, unless the people themselves are going to do their share of work and apply the advice given to them with regard to their own large or small smoke-making appliances.

1933


The proper conduct of a municipal smoke-abatement program is dealt with generally. Particular mention is made of railway, marine, and stationary heating plants.


Where a fire-prevention division exists as an established unit for the Fire Department, its services may be utilized in place of a specially appointed staff to assist in active “air-cleansing” operations and smoke prevention.

In the case described (Schenectady, N. Y.) the fire-prevention unit consisted of a fire marshal, with one assistant, and a chief inspector, with six assistants. Originally quite unversed in smoke-abatement procedure, these non-technical officials were given special training and taught to gauge smoke densities by means of the Ringelmann chart.

Smoke “violations” were reported on special forms, and both the offenders and the authority notified. No technical advice was offered by members of the unit, but the services of an engineer were made available to persons seeking advice on boiler and flue construction and the technology of fuel consumption.

This “low-cost smoke-abatement plan” was not an aggressive or speedy method of giving the community its place in the sun, but provided the means of keeping an existing system from complete extinction (during a period of depression) and the view is expressed that it or something like it might enable other cities “to inaugurate atmospheric sanitation in the face of economic odds.”

It is a little difficult to understand how the continuous duties of this scheme could be carried out without undue interference with those of fire prevention or of how officers concerned were usefully employed before its inception; but the scheme as worked in a manufacturing town of 97,000 inhabitants is fully described. (BH)


Two year’s work in Hudson County, N. J., has reduced smoke 80 percent in that vicinity. This has improved health and combustion efficiency.

1934


The records published in full in the annual reports of the Department are summarized and conclusions are drawn.

In addition to the generally recognized ill effects of breathing smoke-laden air, men performing physically hard work may be expected to suffer more than sedentary workers owing to the deeper breathing required.

Tables are given in which the changes taking place during the last few years are indicated. They show that from 1915–16 there was a steady improvement in atmospheric conditions until 1921–22 both in respect of total deposits and of little sulfates. From 1922 until 1933 there has been little, if any, improvement.

For a comparison of the relative smokeiness of different cities a table is given showing: Rainfall, total insoluble matter, total soluble matter, and total solids deposited at 76 stations for April 1933.

A table showing mean monthly figures for a group of 47 stations shows the deposit for the current year and
its percentage of the general average. This indicates whether the general tendency is toward improvement or otherwise. For 1932-33 a slight improvement is noticeable.

Two methods for measuring the sulfur pollution of the air are referred to. (BII)

1935


When the enormous power plant at Battersea was erected close to the center of London, one condition laid down was that the company should take the best known precaution for the due consumption of smoke and for preventing the evolution of sulfur oxides.

The history of the solution of this problem is related.


The smoke nuisance as it exists in Salt Lake and its possible remedy are considered.


The steps taken to eliminate smoke by a single power plant, thus promoting good will in a community near the Seattle Gas Co. plant on Lake Union, are detailed.


The treatment of gases that are produced as an unwanted part, or as a byproduct, of a manufacturing or chemical process, is considered. The manufacture of superphosphate for fertilizers with oil refining, and the fabrication of viscous rayon are dealt with particularly.

The poisonous silicon tetrafluoride gas, produced in phosphate works, is wet with a water spray, passed through a settling chamber where silica is liberated, and then the gases are subjected to countercurrent scrubbing, which quite efficiently removes the objectionable fumes.

Objectable hydrocarbon- and sulfur-containing gases liberated in the processes of oil refining are either compressed or completely burned.

Deodorization is suggested as a means of deodorizing the gaseous effluent from the production of viscous rayon. This treatment, although it acts upon the organic sulfur constituents has no appreciable effect upon the liberated hydrogen sulfide. (CLAC/UGLA)

1936


In presenting the principles in boiler design the following points are covered: (1) Characteristics of fuel to be used and the most available coals tributary to the plant location must be thoroughly determined; (2) characteristics of plant load determined by careful tests and preliminary survey to fully establish the conditions of boiler-plant design; (3) type and design for stoker and boiler equipment to meet the above requirements; (4) grate and heating ratio limited for coal plant load; (5) furnace volume correct for heat release limits; (6) relation and setting of boiler and stoker for greatest overall efficiency; (7) effective application of secondary air under control for smoke elimination and efficiency; (8) limitation of investment depending upon character of operation to reduce capital.


Information in which smoke-abatement engineers and executives are vitally interested is classified as follows: Engineering of the stoker installation, coal distribution on the grate, air distribution to the coal, combustion in the fuel bed, combustion in the furnace, removal of gases from the furnace, removal of ash from the furnace, mechanical reliability, and service. These items are discussed in detail.


Attention is called to the advantages gained through the elimination of smoke in the engine house, and fuel economy.


Changes to a boiler plant to eliminate smoke are described. These changes are illustrated in detail. The motivating circumstances that induced the improvement was the enforcement by Toronto officials of the smoke law which permits 6 minutes of black smoke per hour. This caused hardships in plants operating with hand-fired boilers. This particular plant had two 1,500-sq. ft. hand-fired boilers in modified Harford settings with breeching running into an 80 ft. steel stack. These boilers had only 28 inches of space between shell and grates. Coal used is long-flame Pennsylvania coal.


Conclusions are arrived at from original observations. The removal of dust is of major importance to steam plant owners and particularly to manufacturers of pulverized-fuel equipment.

1937


Progress is reported in research on methods for burning smokelessly ordinary coal in the domestic grate. Reference is made to a novel device of a self-lighting, smoke-reducing coal fire. The statement is made that the kitchen and hot-water departments of a house can be made absolutely smokeless by use of the latest appliances.


The underlying principles of the type of scrubbing where certain gaseous constituents are removed from the main gas phase and transferred either chemically or physically by absorption into a liquid are presented.


The subject was the problem of reducing air pollution caused by power plants. Ever since man has used fire, he has faced the problem of air pollution by products of combustion. As man progressed he cut a smoke hole in the top of his tent. This idea finally evolved to the status of a chimney.


A review is presented of the steps taken to eliminate smoke in New York City. Smoke, no matter how little it may be, is an index to imperfect combustion and reduces efficiency. With 4,000,000 tons of coal burned a year in New York any increase in efficiency would justify the expenditure of considerable time and money. Selection of the proper coal for each furnace is essential. The usual laboratory test is not sufficient. Actual test cargoes must be used to find the coal best suited for its particular characteristics.
Includes four articles covering various phases of smoke abatement by O. P. Hood, former chief of Technology Branch, Bureau of Mines. Lists six essentials of successful smoke-abatement program—Hood plan.


The vital interest of the coal industry in smoke-abatement problems is stressed. As consulting engineers, architects, and building contractors have as vital a stake in the picture as the coal industry, the latter is spending (1938) approximately $150,000 in an educational campaign in the architectural and building magazines and technical journals to show the architects and builders what it means to them to specify in their recommendations to their clients the proper type, kind, and size of equipment.


The value of the work of the Smoke Prevention Association to the Heating, Piping, and Air Conditioning Contractors National Association is emphasized. The latter organization is primarily interested in the quality of air, with the difference that it is concerned with the quality of air in an enclosure, whereas the Smoke Prevention Association is concerned with the quality of air in an entire city and its environment. Although the control of temperature, moisture, and motion is beyond the scope of the Smoke Prevention Association, it controls to a large extent the cleanliness of the air through the prevention of smoke and other pollution. Another important effect of the Smoke Prevention Association on the Heating, Piping, and Air Conditioning Contractors is that the regulations of the former cause the latter to install properly sized plants that will operate economically and therefore give greater satisfaction. Also, as air cleansing is of great importance in an air-conditioning apparatus, the cleaner the air to begin with the better will be the results. Another factor of importance is that anything that helps to make the public conscious of the value of clean air is of real value to the contractors.


The cost of smoke in England, which, “taken as a whole, is the filthiest country in the world,” is computed to be 2,000,000 pounds annually.

The solution of the problem is in the hands of the people. Although, as is known, the necessity for smoke abatement, they are unwillingly to give up their coal fires, which together with office fires contribute 80 percent of the “horrible smoke.”

The suggested remedy of the use of gas and electricity also is opposed by the coal industry. It is suggested that the Government commence by legislation to abash the use of coal in all offices and in houses above a certain taxable value.


Although most atmospheric pollution arises from the combustion of coal, such operations as smelting of various ores, production of pig iron, manufacture of portland cement, and production of sulfuric acid, are sources of foreign matter discharged in the atmosphere. Several different types of devices and equipment for treating gases arising from these various sources may be divided into the following classes: settling chambers, mechanical collectors of various types, scrubbers, filters, and electrical precipitators.

These various devices are described and their effectiveness and efficiency discussed.


Discusses 17 reasons why 90 percent of the 14,000,000 central heating systems in homes or buildings in the United States need modernization, repair, or replacement.

Judged by modern standards, 90 percent of such equipment is obsolete. Compared to an automobile, the average furnace or boiler is of the Model T variety.

Virtually all complaints or troubles the home owner has with his heating system are first charged to the coal used and made to the coal dealer. In one instance, in which 2 percent of the service calls was the trouble due to the coal. Inspectors have found heating plants in a almost unbelievable condition. They have found boilers with soot 2 inches thick on all heating surfaces, no doubt requiring three times as much fuel as necessary. The Wisconsin State Inspection Department requires that persons installing new mechanical heating equipment submit it for approval, and the Department checks up on the heating load of new boilers before installation.

Smoke is unnecessary and uneconomical. The time has come to require modernization, rehabilitation, or replacement of inadequate fuel-burning equipment with modern, properly designed furnaces, boilers, controls, and stokers. Smoke has no defense. It can be eliminated. Use of proper equipment is the answer.


The value of public cooperation and the place of the engineer in the abatement of smoke are discussed briefly. The value of the participation of the coal industry and other agencies in eliminating the smoke nuisance is stressed.


A general review, based on some original tests, is given, and definite recommendations are made.

The development in design of modern high-pressure high-efficiency steam-generating units is reviewed with particular emphasis on the furnace fuel-burning equipment and boiler. The superheater, economizer, air preheater, and forced and induced draft fans are mentioned in passing. The graphs form an essential part of the presentation and should be consulted in the original paper.


Measures for the reduction of smoke from domestic stoves and fireplaces are suggested. It takes a lot of patience and hard work to convince a community that usually the private homes are guilty of causing one-fourth to three-fourths of the total smoke nuisance during the heating season.


The properties of coals that affect their burning characteristics are summarized by the author as follows:
(a) The tendency toward visible smoke and completion of combustion are functions of the type of hydrocarbons produced by the heat decomposition of the volatile matter. These hydrocarbons may or may not be of such a type that they readily burn to completion with relatively no visible smoke. (It must be remembered that there are many other variables, such as heat release per cubic foot, chilling surfaces, etc., that affect this or, in other words, determine to what extent the combustion will be completed and visible smoke will be eliminated.)

(b) The ash and clinker formations are functions of the properties of the minerals in the coal, and, as some of these minerals have more than one effect, the fusion point of the ash does not necessarily indicate the behavior of a given coal in a firebox. Sulfur is the most common element in coal that produces efficient objectionable both to vegetable and animal life.

(c) Plasticity of the coal in the firebox and coking tendencies are a result of the presence of certain bitumens in the volatile matter and are not easily determined by chemical analysis.

(d) As there are many variables that determine the burning characteristics of a coal other than the properties of the coal itself, it seems that the best method of studying a coal is by an actual test in the firebox in which it is to be used.


The development of a new model scrubber for removing fog, dust, and other particles from gas and air is announced.

1940


The progressive improvement made by railroads year by year up to the present has reduced the smoke produced by locomotives in cities to a minimum. It is proof that the problem can be solved by intelligent, systematic, and persistent supervision and with regular equipment and fuels.

Two scientific announcements in connection with power generation are discussed.

1931

1930. BLACK DIAMOND. Coal Producers Smoke Abatement Committee Meets in Cincinnati. Vol. 107, 1941, p. 0.

More than 100 Appalachian producers and railroad representatives met in Cincinnati on September 26 to devise a program that would help solve the smoke problem in Cincinnati and all other metropolitan centers as well.

The program suggested calling for the expenditure of $2,000 annually for 3 years, with the operators’ association and the coal-carrying railroads sharing the expense.

Success attained at Atlanta, Ga., was cited as indicative of what could be done in other metropolitan centers where smoke agitation was likely to result in passage of an antismoke ordinance.

When the meeting adjourned it was evident that the program outlined would be placed in operation in the near future.


Dust-polluted atmospheres are ranked high in the list of public-health enemies these days. Although smoke is not the only source of air defilement, it is the most vulnerable to attack. That means that any smoke-abatement campaign puts the coal industry under fire.

St. Louis was the storm center and Pittsburgh now has that unenviable distinction, but Cleveland and Columbus also are pressing for action, and the battle is winning recruits in still smaller communities.

The pure-air movement cannot be wished out of existence. Blind opposition will only strengthen it and encourage its more starry-eyed partisans to go to excess. Active participation is the better way. Since the coal industry has most at stake, public-spirited coal men should take the leadership in the campaign. In that way, working with and through other civic groups, as was done in Chicago several years ago, objectives that are not more injurious to the community than the benefits they confer may be attained.

1932. ———. Chemists Assembling at St. Louis Seek Ways To Cleanse Air of Smoke and Dust. Vol. 46, 1941, p. 84.

Six roads to brighter skies for cities—smokeless coal, smaller coal sizes, better prepared coal, processed coal, fuels other than coal, and electrostatic precipitation—were advocated by the Division of Gas and Fuel Chemistry at its meeting with the American Chemical Society.

Various phases of the smoke problem and its control are presented in the report of the meeting. The difference between gross and net heating values of various fuels is given. The statement is made that smoke cannot be eliminated unless either the equipment will burn the available fuel smokelessly or a smokeless fuel is used.


Some of the results of the smoke-abatement regulations in St. Louis are discussed in a general way. The city is said to be relatively free of the smog that formerly settled over it, particularly during the winter months.

Refers to the effort being made in Pittsburgh to clear the atmosphere.


Refers to the relaxation of smoke-abatement efforts during the 1st World War. This was inexcusable and false economy. The National Smoke Abatement Society of London, England, after pointing out the danger of smoke as a guide for attacking enemy aircraft, issued a statement of a national fuel policy. The society urged that the most careful consideration be given to a national fuel policy. Smoke was said to be a byproduct of the technologically primitive phase of our industrial civilization from which we have not yet emerged.

As another world war is entered the carelessness and waste of smoke and other forms of atmospheric pollution cannot be afforded.


Refers to the mass destruction and tremendous waste of life and property inflicted by war. Conservation of resources and material and economy is vital to the survival of the American way of life. All waste must be stopped or reduced to a minimum.

Emission of dense smoke from stacks is a pure sign of preventable waste of fuel. It is imperative every day to save fuel because it is the most vital essential to a defense program. Without steam heat, or power, everything would come to a complete stop. The Smoke Prevention Association has a definite duty in promoting economy and efficiency in the use of fuel by aggressive activity in smoke abatement and prevention of air pollution.

Until probably the last 10 years in Atlanta smoke was a sign of progress, but it is now known that we can continue to have progress and still abate smoke. Eliminating smoke, however, should not make it too expensive to do business. Smoke abatement carried out intelligently would be a magnificent forward step.


The organization and aims of the Coal Producers Committee for Smoke Abatement, organized in 1941, are described.

The committee is composed of representatives of the coal-producing districts of Western Virginia, Kentucky, Tennessee, and Virginia. It has a paid staff of engineers and supervisors and has the power to draw on the services of approximately 50 outstanding fuel engineers who are associated with member companies.

The services of this staff are available to municipalities in the Middle Western and Southern States who are interested in improving smoke-abatement activity. The program usually consists of weather-record studies, engineering surveys of industries and commercial plants and railroads, an analysis of domestic coal-burning equipment, assistance in the preparation of smoke ordinances, alterations to building codes of municipalities, assistance in the organization of smoke departments, educational work, and recommendations.

The committee endorses the Chicago plan as offering a permanent solution to the smoke-abatement problem, principally because it is economically sound.


Describes results of Birmingham's smoke-abatement program.

The first year of a city-wide "swat the smoke" smoke-abatement campaign has accomplished definite results, among which has been the installation of improved firing equipment in a number of plants. In addition to installing underfeed stokers, some of the plants found other means of eliminating smoke.

In a number of plants, notably laundries and dry cleaners, overfire steam jets were installed to draw in air over the firebed. Soft coal is the fuel used. The county courthouse, which uses coal pulverizers, found also that installing air vents over the firebeds eliminated smoke. In still other plants the answer to the smoke-elimination problem was found in using a chemically treated coal. Actual demonstration has shown that soft coal can be burned with very little smoke.


Presents the many factors that determine whether or not a given coal will heat from spontaneous combustion under given storage conditions and discusses the causes. Methods of storage to prevent spontaneous combustion are described in detail.

Some of the methods suggested are storing under water, storing in an open pit in the earth, storing slack coal in layers, capping coal pile with airtight coverings, and storing in bins, bunkers, and silos.

Testing the temperature of a coal pile periodically gives plenty of warning and ample time to avoid danger.


Discusses what smoke is and how it is formed as well as the different possibilities available for the successful suppression of smoke formation produced from different solid, liquid, and gaseous fuels, and its elimination before it can do harm.


The contribution made to promotion of better fuel utilization and distribution by the fuel engineers identified with Bituminous Coal Research, Inc., is mentioned briefly. The 5-year research program, sponsored by the coal industry and the originating railroads, is the most extensive ever attempted and will involve the expenditure of more than 2 million dollars.


Reduction of smoke in postwar London is reported as being considered at a conference of 67 boroughs and other municipal authorities and members of the Greater London Advisory Council for Smoke Abatement. The conference was reminded that the Government had not been inactive. Between 1919 and 1923 there was improvement of about 50 percent in the deposits dropped on London. Then there was a stationary period and some deterioration, but between 1928 and 1939 there was improvement again.

Refers to the limited supply of naturally smokeless fuels and a relatively small supply of carbonized fuel for use in postwar housing. Progress is hoped for in the manufacture of a really satisfactory improved grate that will burn raw coal more completely and also will burn smokeless fuels satisfactorily.

Mentions the losses owing to smoke from open fires that the British public likes. The Minister of Health stated that he was anxious to avoid smoke in the new suburbs and prevent the continuous spoiling of the center of the cities.


Plants that are of obsolete design and poorly operated are the chief contributors to the smoke nuisance. Operating methods and problems peculiar to waterworks plants are considered in this paper. The basic difference from other general business enterprises is the problem of continuity of service, which may make it necessary to generate power to avoid service interruptions.

The importance of clean air and the lack of public concern at Bolton, England, is the center of discussion. The increased death rate from respiratory diseases in smoky towns is stressed, as also are the generally unhealthy effects of reduced sunshine. Recommendations include: (1) A national publicity campaign; (2) local restriction of air pollution; (3) licensing of the stokers; (4) laws governing boiler equipment; (5) control of fuel; (6) approval before installation of new plants with regard to abatement equipment and policies; and (7) employment by health department of sanitary inspectors.


The problem of conserving fuel is discussed under two parts: Saving coal by obtaining more effective heat from each pound burned, and saving coal by actually eliminating the burning of coal.

The first part may be accomplished by effective equipment and efficient operation. The second part may be accomplished by following the suggestions for home owners, which include installing storm windows, in- sulating the home, and various other schemes for reducing the necessity for producing more heat than actually required for comfort.


Gives a brief history of the research program of the bituminous-coal industry. At first the research was on a small scale, but in 1944 the industry was in a position to launch officially a 5-year full-scale program. Evidence that the industry is in earnest is witnessed by the fact that more than $2 million has been subscribed to the program, with more to come. About 100 research projects will be pursued. A glance at the list of projects by any smoke-minded person will reveal that progress made in virtually every category will in some manner be related to smoke elimination. Although not directed entirely toward smoke elimination, it is directed toward the improvement of combustion equipment, and this in turn will accomplish that purpose. The paper of the program to be followed is outlined. Its success is presaged by the valuable accomplishments of the modest program that preceded it.


The problem of atmospheric pollution, caused by solids emitted by coal-fired boilers is considered under two headings—stoker firing and pulverized-coal firing. The burning of black smoke or soot from stoker-fired boilers is not discussed, as this results primarily from inefficient boiler operation and no particularly effective equipment is now available for this purpose.

A wide variety of equipment is available to collect the cinders and ash from stoker firing and the fly ash from pulverized coal firing. The types generally employed here and abroad may be classified as mechanical collectors, gas scrubbers, filters, and electrical precipitators. The various devices and equipment under these classes are described in detail.


As its first major project since its reorganization, the Coal Producers' Committee for Smoke Abatement has completed arrangements with officials of Toledo, Ohio, to conduct an exhaustive survey of power and industrial plants, as well as schools, churches, apartment buildings, public buildings, laundries, and dry-cleaning establishments.


The National Smoke Abatement Society has sent a memorandum to municipal authorities setting out the importance attached by the Government in the new housing manual to the reduction of the amount of smoke emitted and offering its help and advice. Expresses the hope that the fullest advantage will be taken of the many advances in domestic heating and approved appliances that will be available. It points out that the matter is urgent even in areas relatively free from the effects of air pollution, for, unless the necessary steps are taken, extensive new housing developments will create their own palls of smoke to the detriment of tests new districts and neighboring property or agricultural land. The memorandum describes certain technical developments in heating appliances and offers to assist housing authorities by obtaining information from manufacturers or trade associations.


Outlines the procedure used under the National Fuel Efficiency Program and some of the results attained by the program. Although it is impossible to give an exact or even reasonably accurate statement of the actual tonnage of coal and quantities of other fuels saved, returns from 9 percent of the pledges received indicate a total saving of at least 5 million tons of coal per year for all pledges.

Under a projected new program the Bureau of Mines will probably merge its work on smoke abatement with that on national fuel efficiency. The two go hand in hand. To obtain important technical data, particularly for city smoke-abatement departments, a series of research projects is planned on various arrangements of fuel-burning equipment and different types of fuels. Lack of this information has handicapped smoke abatement for years.

1953. SMOKELESS AIR. Smoke Prevention and the Minis-


In the debate on the Ministry of Fuel and Power Bill, which assures continuation of the Ministry after the war, an amendment was moved that would include in the functions of the Minister "the abatement of smoke and other nuisances arising from the consumption of fuel or utilization of power." In the debate the damage done to health etc. by atmospheric pollution was emphasized by several members.

1953. THE YORKDALE BACK-TO-BACK RANGE. No. 38, 1945, p. 17.

This is an openable stove of the new type, which, when the doors are opened and pushed back into the recesses at the sides of the stove, has an appearance differing little from the ordinary open fire. The stove will burn all kinds of smokeless fuel, and, if necessary, bituminous coal. On the kitchen side is an oven, with a fire from the fireplace, combined with a gas cooker. This arrangement enables the housewife to carry out the daily cooking either by solid fuel or gas. Additional warmth is provided by the use of convector heat. Fresh air can be brought into the room from the outside and warmed before being discharged into bedrooms on the first floor through controlled ventilators at skirting board level.

Industrial atmospheric-pollution nuisances include inert smokes and dusts, mucous membrane irritants, and malodorous substances. The minute smoke particles are rarely a cause of complaint by urban populations. Odors are very difficult to evaluate and localize. After the source of the nuisance is determined, the investigator must find what changes in plant processes will alleviate the situation. Rather than repeatedly persuade or force management to control the recurring nuisances, dependence should be on long-term planning, such as careful industrial zoning and enlightened legislation. (JHIT)


To provide the basis for planning the abatement of atmospheric pollution in New York, data were obtained on the quantity of each fuel type burned in the city in 1935, its geographic distribution within the city, and the number, size, and use of each unit of fuel-burning equipment. By survey (356-377) in New York City buildings. The use of this fuel-consumption data to predict the intensity of atmospheric pollution has been demonstrated. This is the first presentation of the final data resulting from the survey. (FA)


This address to the Ottawa Smoke Nuisance Committee considered smoke control in its three main aspects, namely, human, economic, and technical, and these are graded in their relative order of importance. Suggests four essentials of a workable plan by which Ottawa can lessen the smoke nuisance. (APB)


The British incendiary bomb was filled with a special benzol gel and white phosphorus. When burned the benzol gel filling produced a large amount of black carbon smoke, which could be targeted. Therefore, the possibility of replacing this benzol gel-phosphorus combination with a smokeless filling of a satisfactory nature was investigated. The smoking tendency of a large number of organic compounds was assessed by flame-height measurements i.e. a special lamp based on the I. P. smoke lamp. A burning organic substance has a flame-height at and above which smoking occurs, and this height is a measure of the tendency to smoke. A new form of lamp was devised to measure flame-heights, from about 9 to 450 mm., of liquid compounds burning freely in air. A wide range of hydrocarbons, alcohols, ketones, esters, and nitro-compounds was examined—115 compounds in all. In general, a compact molecule was found to give a smoky flame. The order for increasing tendency to smoke for hydrocarbons is n-paraffins (in which increased chain length or chain branching gave increased smoke). In general, increased oxygen content of an organic compound resulted in decreased smoking tendency, and compounds, such as methyl acetate, containing high percentages of oxygen only smoked at very large flame heights.

Some compounds, such as allyl alcohol, although having appreciable oxygen contents, had relatively high smoking tendencies, owing to the nature of the carbon-hydrogen portion of the compound. Of the aliphatic alcohols, the tertiary compounds were more smoky than the primary compounds. This also applied to nitro-paraffins. For each isomer of aliphatic esters, the flame-height at which smoking began increased with the chain length attached directly to the carbonyl carbon atom. At equal oxygen content, the general order for increasing tendency to smoke was: n-primary alcohols, n-primary nitroparaffins, propionates, acetates, lactates, and formates, although the order varied slightly for different oxygen contents. (APB)


The book deals with all phases of smoke prevention and offers a solution to this problem. (APB)


The importance of adequate control, preferably automatic, of all industrial fuel-burning equipment in relation to smoke abatement and fuel economy is stressed. Discusses control of stokers, airports, fine-gas temperature, overfire draught, and dampers. (FA)


The abolition of smoke would be one of the greatest social reforms in Britain. Smoke wastes coal; it is estimated that 3.3 million tons of coal is wasted annually in domestic smoke to which must be added industrial smoke.

The burning of raw coal should be avoided as much as possible as it involves destruction of many valuable chemical products. The domestic fire is the greatest offender in smoke production. Every possible encouragement should be given to the use of coke or smokeless fuels for domestic heating and cooking by fostering the development of suitable appliances and by adopting up-to-date methods of house construction to reduce heat loss.


It is suggested that an entirely different angle from the technical one might play a greater part in the success or failure of the smoke-elimination program. Four examples are given to illustrate the point. The need is stressed for publicity and propaganda. Schools, engineering and technical institutes, teacher training institutions, women’s clubs, and service clubs are mentioned as organizations that could assist. (APB)


A short note is included on the reduction of atmospheric pollution. (FA)


An aggressive public sentiment must be built up that will induce offenders to take the interest necessary to adopt corrective measures. The air-pollution offenders must be divided into a number of classes of similar type. Instruction or education in proper operation and maintenance suited to the needs and comprehension of each class must be provided. Equipment, apparatus, stoves, furnaces, and stokers must be developed that embody the vital principles of complete and smokeless combustion and eliminate ancient methods of fuel operation. Input of fuel per unit of time must be reduced to a point where the furnace can digest the fuel for complete combustion. The fuel must be fed in very small increments. The next requirement is uniformity. All coals contain ash, and this is not more formed, uniformity of fuel-bed condition is impossible. The third fundamental is the proper supply of additional air over the fire, so that the volatiles may be supplied with the necessary oxygen close to the fuel bed. (APB)
CONTROL OF AIR POLLUTION


Deals with a number of points that will aid the mitigation of smoke problems in industrial districts. (1) Cleaning fly-ash accumulation at base of stack by stirring up ash so that it is discharged out of stack. This "easy" method of getting rid of fly ash is one of the principal causes of heavy dustfall. The proper method is to wash the surface of the ash accumulation at the base of the stack before the clean-out door is opened. (2) Cleaning breaching and settling chambers in boiler at irregular and infrequent periods. When fly ash accumulates in a breaching or other space intended for gas passage, flue-gas velocities increase. As a result, ash is prevented from settling out of the steam of the flue gases. (3) Burning rubbish in base of stack or on grate of unused boiler with damper wide open. This practice permits discharge of large quantities of burned paper into the atmosphere. (4) Using cleanout door in a boiler room. An open cleanout door reduces the available draft in the furnace, often causing it to smoke. (5) Blowing tubes with dampers wide open or opened at frequent intervals. When tubes are opened, discharge of solids range up to 100 times the normal discharge. Therefore, great care should be exercised when tubes are being blown. (6) Operating a steam ash ejector that is directly vented into boiler stack. A steam ash ejector directly vented into a boiler results in fine ash being discharged out of the stack.


Attention has been given during the past 10 to 15 years in the U.S. S. R. to the study of solar energy received under natural conditions. Records of solar radiation with a thermoelectric reception of radiation and a recording galvanometer. The apparatus and its use are described briefly. Daily records are obtained. The author gives tabulated data and curves to show the variations in the amount of solar radiation received in different latitudes under different atmospheric conditions. Brief reference is then made to the principles of and first attempts at the practical utilization of solar heat. Highly successful results were obtained with a heat accumulator designed by Trofimov, when exposed to the sun in the climate of Tashkent. On a sunny day, according to the results quoted, the temperature in the heat accumulator has risen to 225° C by 3 p.m.

In the Uzbek S. R. "solar boilers" on Trofimov's principles were installed in 1936 for domestic hot-water supply, laundries, public baths, etc. The first experimental bath-house was built in 1932 and was used by several thousand people. A water-distillation apparatus utilizing solar radiation and based on the principle mentioned has been designed by Trofimov. There are revolving and fixed types of distiller as well as regenerative, that is, in which the heat condensation is utilized for the evaporation of water, and nongenerative types. (APB)


Remarks are directed to those aspects of smoke abatement that deal with steam raising and heating plant and arrangements for domestic cooking and heating. Sources of power other than coal are considered and some statistics are given. Common causes of smoke nuisance are discussed. (FA)


The effect of smoke-abatement surveys, which have been carried out in many cities in the United States, has been to impress upon the public the necessity for an immediate, planned, nonpolitical approach to the problem. To this end every municipal official must see that the correct type of well-cleaned coal is supplied for every type of appliance. (FA)


The work described was undertaken at the request of the Consumer Products Branch of the Office of Production Research and Development of the War Production Board. The problem was the experimental investigation of a proposed system of solar energy, principally for house heating. The proposal involved a group of partly blackened, overlapping glass plates mounted on a house roof. A semicontinuous glass cover over the staggered plates was proposed. By virtue of the high transmission of glass for solar radiation and the low transmissivity for long-wave thermal radiation, the black and clear glass surfaces in the unit would become heated when exposed to sunlight, and the reradiated heat therefrom would have no avenue of escape. Air passing between the plates could be heated and supplied to the house. A second proposal, not studied experimentally, concerned storing the heat collected by passing the hot air through a bed of loosely packed, cheap solids, to which the sensible heat of the air was transferred. Delivery of the hot air from the storage bed could then provide heat when no solar energy was being received.

The first experimental unit was constructed indoors and irradiated artificially with a bank of tungsten lamps. In a complete study of the operating characteristics of this unit, it was found that the principle was actually workable and that a construction involving two-thirds overlap of plates blackened one-third their length on the upper surface, and spaced 0.04 inch apart resulted in the best performance. The results obtained were used in the design of a large-scale collector, constructed on the laboratory roof and operated intensively over a 3-month period in the autumn and run intermittently through the winter. The variables measured and correlated included the solar-heat input, heat collected, efficiency of collection, entrance and exit air temperatures, air-flow rate, plate spacing, and temperature required for establishing heat balances. A third unit was then constructed on a mountain top connected by ducts to the regular hot-air heating system. Electrical connections and automatic controls completed the installation. The results show that the principle is workable, and that by its solar heat can be recovered with efficiency of 35 percent to 40 percent, with exit air temperatures above 150° F. at noon on a bright day. Higher temperatures can be obtained but at lower efficiencies. Tilting of the collector to the south is desirable, and roof slopes ranging from the angle equal to the latitude, up to approximately 10 degrees more than the latitude, remains the optimum. Breakage of glass plates exposed to solar radiation, remains the greatest problem. The way in which thermal stresses cause this breakage is subject of a new investigation. Operation of the house unit during one winter showed that a fuel saving of about 20 percent was being realized.

Limited data indicate that the house hot water can be supplied by the solar hot water heater during the summer. Locations north of the 40th parallel are generally unfavorable for economical solar house heating. (APB)


Dr. Metcalfe Brown, M. O. H., has recalled that Manchester has taken a leading part in smoke abatement for many years; its first smoke inspector was ap-
pointed more than 80 years ago (1864). At present there are four full-time smoke inspectors employed at the public health committee's request from the work of these inspectors in enforcing the smoke-abatement provisions of the Public Health Acts, their advice has been much appreciated by owners of steam-raising plants. In many instances not only has smoke emission been prevented as a result of suggestions by these inspectors, but operating efficiency has been improved and economies effected in fuel consumption. The corporation was active in 1924 in the formation of the Manchester and District Regional Smoke Abatement Committee. One of its objectives was with the object of attainment when the war commenced—the establishment of a statutory joint board in south-east Lancashire for the purpose of administering smoke-abatement legislation. At the suggestion of 22 local authorities, including Manchester, had agreed to join the proposed board and four had signed conditional assent. In the educational sphere the regional committee, though operating on a voluntary basis, has done good work in organizing courses for boiler firemen, supervisors, and executives concerned with the management of boiler plant. These courses have been well attended, and the committee has awarded certificates to candidates successfully completing the examination. The public health committee's concern over the abolition of smoke is shared in other directions. Just prior to the outbreak of war it considered a suggestion by the National Smoke Abatement Society regarding the establishment of a smokeless zone in the city. A survey made of an area of 184 acres in the center of the city revealed some interesting facts with reference to plant and appliances and their smoke-producing potentialities. It was demonstrated that the establishment of a smokeless zone in the area concerned was a practical proposition, but the war prevented further consideration and exploration of this matter. Manchester has a further interest in smoke abatement through its cooperation with the Department of Scientific and Industrial Research in the investigation of atmospheric pollution. The corporation has taken steps to deposit gages and sulfur estimation apparatus in various parts of the city. (FA)

Consideration was given by Poplar Borough Council to the subject of preventing atmospheric pollution by the provisions of the station's construction at Brunswick Wharf. A gas-washing plant is wanted, and the Borough Council resolved to support the I. C. C. in favor of making representations that the question of the emission of fumes generally should be investigated. This would define the extent of the discharge into the air of fumes from installations such as electricity generating stations and other installations consuming large quantities of coal. In reply to these representations the Ministry of Health intimated that a committee has already been appointed by the Department of Scientific and Industrial Research, under the Chairmanship of the Director of Fuel Research and has issued a report covering generally the first part of the terms of reference suggested by the London County Council and recommending that actual experimental investigations should be initiated. The Ministry stated that such experimental work is to be carried out at Fulham, but little progress has been made, owing to difficulty in securing certain requirements. (FA)

Some important conferences were held during the year, and a resolution on the need for avoiding the installation of solid fuel-burning appliances of obsolete type and inferior efficiency in new houses was sent to the Government departments concerned.

Towards the end of the year the New Towns Committee of the Ministry of Town and Country Planning invited the society to submit a memorandum showing that in the planning of the proposed new towns complete prevention of smoke should be secured, and the new towns regarded in their entirety as smokeless zones. Considerable changes have been made in the constitution of the society. The new governing body, the Executive Council, the divisional structure, new methods of election, and new subscription scales should together make it a much stronger body with greater capacity for development than was possible under the original constitution. (FA)


Research is summarized on equipment to prevent smoke sponsored by Bituminous Coal Research, Inc., the national research agency of the industry. This organization is supported by about 250 coal-producing companies and associations, 10 railroads, and several equipment manufacturers. Battelle Memorial Institute has been concerned with determining the most effective and economical designs for steam-induced air jets, and developing compact silencers for reducing the noise from such jets. Research on the application of overfire jets to the burning of coal in stationary plants has also been initiated by Bituminous Coal Research, Inc. The most revolutionary research that Bituminous Coal Research is sponsoring on smokeless combustion is that on the coal-burning gas turbine, which promises to set new standards of cleanliness for burning coal for many power uses. It is proposed to crush and pulverize coal on the locomotive and to burn the coal under several atmospheres pressure in a vortex combustor of novel design.

The locomotive is expected to have about three times as high thermal efficiency as typical steam locomotives in main-line service and to be entirely free from smoke and cinders.

At Battelle, a study of methods of obtaining uniform flow of pulverized coal to multiple-burner installations has resulted in development of a reliable meter for measuring the amount of coal in mixtures of pulverized coal and air flowing through pipes. Incorporation of a meter in the transfer line between pulverizer and furnace entrance gives further control of the proper proportions of fuel and air for optimum combustion and minimum smoke. In the sphere of residential and small commercial heating projects in hand include residential group heating, improved designs for coal-heated homes, better chimneys, and various developments in connection with automatic and hand-fired equipment. The development of smokeless hand-fired heating equipment forms an important part of the research program. At the Coal Research Laboratory of Carnegie Institute of Technology, fundamental research in progress includes work on organization and gasification and combustion reactions. These studies are designed to have broad usefulness in supplying basic facts that will permit the development of improved processes for making smokeless solid and gaseous fuels. (APB)


Data are given on waste of fuel by industrials, railroads, fuel producers, and electric and gas utilities; analysis reveals that greatest waste (18.4 percent) is from industrial use of fuels. Domestic heating (10.8 percent) is third on list. Recommendations are given to alleviate detrimental prevalence of smoke, soot, grime, and existing national fuel shortage. (APB)
CONTROL OF AIR POLLUTION


To comply with the air-pollution regulations of industrial municipalities—yet operate economically—the three prime factors, (1) coal characteristics, (2) boiler and furnace design, and (3) operating personnel, must complement each other. It is unreasonable to expect any one of these factors to be charged wholly with the responsibility of economical steam costs and acceptable chimney discharge of smoke or fly ash.

Discussion of some of the relations between coal characteristics and plant design that should be considered before design specifications are written. Too often plants are designed and burning equipment specified without first having a complete knowledge of the characteristics of all the coals normally available over the life of the plant.


Chapter 27 is devoted to smoke prevention. Domestic and industrial problems are reviewed, and there is a summary of the main efforts in the past. The importance of smoke prevention in health education is stressed, and an account of practice in the United States is included. (FA)


The work is described of the Coal Producers’ Committee for Smoke Abatement in assisting cities throughout the country by analyzing smoke problems and suggesting remedies for their solution. (APB)


A large percentage of buildings have incinerators that burn waste, garbage, and combustible material; in other buildings this waste material is disposed of in heating furnaces. Few of these units can burn this material satisfactorily unless the fire bed is maintained at an elevated temperature. Disposal of this material results in one of the major sources of pollution that cities experience. Nuisance is also created by industrial plants burning waste and refuse in open lots. This material can usually be burned to better advantage in incinerators or pits equipped with high-pressure air jets as well as by burning in lesser quantities or by disposing of it more frequently. Arrangements should be made to incorporate in the building code provisions for properly designed incinerators. (FA)


A survey of 145 plants, including 226 boilers and 302 individual pieces of heating equipment, is reported, and analyses are given of many other factors contributing to atmospheric pollution including topography, wind velocity and direction, and industrial diversification. Recommendations for the elimination of smoke are given. (APB)


The chlorination of molten Al alloys for removal of certain elements, such as Mg, results in the formation of AlCl3 vapor, which, when exhausted to the atmosphere, upon hydrolysis, creates dense and voluminous smoke. The use of high-efficiency filters, etc., was not sufficient to prevent a nuisance. It was found that if the furnace effluent gases were mixed with steam Al(OH)3 would be formed; at 600° F. the latter would be exploded into much larger particles of Al2O3. Successful results were secured in a pilot plant in which a steam was introduced into the flue leaving the furnace; after passing through a sufficient length of flue to give the desired contact, the gases were passed through an acid-proof tower packed with Beri saddles and then through a secondary filter packed with graded fiberglass. This latter filter removed unchanged Al(OH)3 at the start of the reaction, and could readily be cleaned by washing with water sprays. Most of the Al2O3 particles were retained by the packed scrubber. This installation was effective in removing the nuisance. (CA)


The various industrial sources of atmospheric pollution are discussed and suggestions are given to eliminate the nuisance. Offending industries include the aluminum and rayon industries and oil refineries. (APB)


Describes work of the Fuel Efficiency Division of the Ministry of Fuel and Power, which is divided into two sections, one dealing with domestic use of fuel, that is, use of fuel in the home and in flats and office buildings, and the second with industrial use in factories. In the survey of domestic uses of fuel, the design and production of improved types of appliances, and their correct installation in new and existing houses, are considered. In dealing with the industrial aspect, the problem of grit emission is discussed and cyclone-type grit arrestors are described briefly. Training of stokers is considered. (APB)


Summarizes the provisions in British and American codes to avoid risk of injury to operating staffs of pulverized-fuel-using plants from (1) explosions, (2) spontaneous combustion, and (3) inhalation of poisonous gases. An account follows of the regulations that took place in 1939 between the Combustion Appliance Makers’ Association and the Minister of Health to secure fair treatment for pulverized-fuel firing in the model clauses regarding control of soot and grit emission to the atmosphere for use in preparing town and country planning schemes by local authorities. An estimate is made of the increase in the annual consumption of pulverized fuel in Great Britain by 1950. (APB)


The Minister of Town and Country Planning was asked (1) whether he has received authoritative evidence as to elimination of sulfur fumes from the proposed oil-fired Bankside generating station; (2) what steps he is taking to satisfy himself that no noise and sulfur or other noxious fumes will be given out by the proposed station; (3) what reports he has received on the possibility of eliminating sulfur and other noxious fumes emanating from oil-fired electricity generating stations. The reply was that sulfur and other noxious fumes can be eliminated. To ensure that the design of the plant to be installed is satis-
factory, a pilot gas-washing plant is to be constructed, and when the results of this are available, the Electricity Commissioners will consult with the Ministers of Health and of Works.

As regards noise, the Electricity Commissioners imposed a condition in giving their formal consent that efficient methods shall be provided to avoid noise, and there is no reason to think that any difficulty will arise. (FA)


Describes efforts made and methods used by the Dow Chemical Co. to eliminate odors, irritants, and aerosols. (USPHS)


Presents the principles underlying the reduction of atmospheric pollution. The familiar pattern of solution generally followed in pressing for a cleaner atmosphere is indicated. Apparently, the subject of atmospheric pollution has not received the consideration its difficulty and importance demand. Questions still unanswered require a carefully planned program and research from a long-range point of view. The subject is so complex and has so many facets that the cooperative skills and experience of many professions are needed. These are listed as follows:

- Combustion engineers are needed for their knowledge in the use of fuels.
- Climatologists are needed for their experience in the influence of the weather, topography, and terrain on the atmospheric-pollution problem.
- Doctors are needed to advise on the extent of the influence of atmospheric pollution on health.
- Economists skilled in engineering economics are needed to warn against fantastic solutions of the problem.
- Statisticians skilled in the collection, analysis, presentation, and interpretation of data are needed to plan the investigation, set up the sampling procedure, and report the results in a modern statistical manner.

Chemists are needed because of their skill and experience in the reactions that take place in this problem. It is imperative that trained skills be brought into close cooperation in studying the matter. The exchange of knowledge regarding the subjects is greatly needed. A close alliance should be made with colleges conducting research in climatology, the U. S. Weather Bureau, and certain cooperating bodies interested in the problem of atmospheric pollution.


The civic trend is to require more and more from industry in air-pollution control. Management generally desires to reduce contamination if it is convinced that there is excessive pollution from their operations and that it is economically feasible to abate the condition. Industry would be well advised to anticipate the effects of the civic trend by assuming the lead in sponsoring urgently needed research. Cooperation with public agencies is also advisable to insure that regulatory actions are based on sound engineering principles. The primary basis for control is the welfare of inhabitants of the community, but gains in this respect will be limited if regulations are impractical. Relations permitting interpretation of community standards of atmospheric pollution in terms of what industry should do must be developed and emphasized. It is difficult to predict what the most serious problems in controlling atmospheric pollution are economic; the most serious are those problems, in which the cost of the only known method is out of proportion to the value of plant operations or to the magnitude of the nuisance. Industrial pollutants are classified according to their unique physical properties. A scheme is presented that is suggestive of procedures for measuring different types of pollution. Control of industrial pollution is effected by tall stacks and by chemical engineering techniques. Stacks approaching 1,000 feet in height may be practical in certain situations. Meteorology, by identifying the most effective "air streams" for the dispersal of pollutants into the atmosphere, can aid materially in the selection of new plant sites that have difficult problems of waste disposal. (FA)


Experiments carried out at the Massachusetts Institute of Technology involve building a bank of glass cubes behind the windows of a solar house and filling them with chemical solutions that retain the sun's heat over varying periods of time. (APB)


The equipment used for heating the atmosphere, the dust- and smoke-control system, and the ventilation at an ordnance factory at Sorel, Quebec, are described and illustrated. (APB)


Some coal men still regard smoke abatement as a dreaded monster to be fought and run from at first sight without giving it any consideration. Many concessions, however, that coal burning must be smokeless if the industry is to survive. Smoke abatement is the key to the salvation of the coal industry.

The first principle in smoke abatement is to select coals for purposes for which they are suited. The coal industry could well leave the defensive attitude in which it has been facing some of its problems, including the smoke nuisance, and aggressively promote markers on the basis of consumer satisfaction.


The importance is stressed of the stability of the coal industry and of the solution of the problem of atmospheric pollution of the proper selection of coal for the purpose for which it is used. (FA)


The Coal Producers Committee for Smoke Abatement has made an engineering survey of heating and power plants in Detroit. This survey embraced a study of more than 500 installations of fuel-burning equipment. The survey indicates clearly that the domestic fuel-burning plants are responsible for only a very small portion of the total annual air-pollution nuisance in Detroit. The actual and potential offenders are listed in order of nuisance. The causes of the pollution in Detroit are outlined, and recommendations are offered for its elimination. (APB)


Excessive smoke is usually caused by (1) improper or inadequately sized equipment, (2) improper fuel, (3) careless firing or stoking (especially with bituminous coal), (4) stacks that are too low, too small in diameter, or subject to downdraft from adjacent structures, or (5) stack deflectors to eliminate fly ash. Control measures taken by St. Louis, Hartford, Stanford, and Norfolk are mentioned. (FA)

In giving their consent to the erection of the bankside power station, the Electricity Commissioners will stipulate that it should use the most efficient methods for eliminating smoke. The details of this requirement will be settled in agreement with the Ministers of Health and Works. Any emission of black smoke would be subject to the smoke nuisance provisions in the Public Health (London) Act, 1936, and smoke-by-laws made by the London County Council. (Parliamentary Secretary, Ministry of Fuel and Power.)


Details are given of the work of the Smoke Abatement Committee of the Coal Trade Association of Indiana, which offers its cooperation to any city interested in a properly organized smoke-abatement program. A survey of the community at Terre Haute, Ind., has been carried out, and the procedure followed there is expected to serve as a model for other surveys. (FA)


Forty-three questions bearing on the abolition of domestic smoke are enumerated. (FA)


Presents reasons for the failure of smoke and dust ordinances and a plan is outlined for eliminating air pollution. Discusses the overfire stoker with cinder reinjection, fly-ash hoppers, the disposal of dust from mechanically fly-ash collectors, the need for overfire air jets and the advantages of smoke indicators with alarms. (FA)


The Fuel and Power Advisory Council of the Ministry of Fuel and Power issued its report on Domestic Fuel Policy early in the year. One of the terms of reference of the council was to consider the abatement of smoke from household fires, and in its recommendations this factor is integrated into the general policy in an entirely satisfactory manner. Proceeding with the important report was the more technical Heating and Ventilation of Dwellings, a report of a committee of the Building Research Board, which also stressed the importance of smoke prevention, and included an informative appendix on atmospheric pollution. To set up smokeless zones, not only in the city but in other parts of the city, and to require the prior approval of all new steam-raising and other industrial or trade installations are important sections of the Manchester (General Powers) Act, 1946, and powers to make by-laws for the prior approval of new installations are included in the City of London Act, 1946. An interesting development in planning for smokelessness is the setting up in Bristol of a co-ordinating Smoke Prevention Committee of all the interested committees of the City Council. In Sheffield the society's suggestion in smoke control has been acted upon by including a smoke-control clause in all leases of corporation-owned land to be used for industrial purposes. (FA)


From a long-distance viewpoint, the attention given by the whole nation during the year to the problem of fuel may prove to be of substantial value to smoke abatement.

Understanding is gradually spreading that if our fuels were used more efficiently the present production of coal would be ample for all our needs. The society comments on the material increase in the number of complaints of "nuisance" caused by grit emission, although it says that it is difficult to obtain quantitative evidence. The report welcomes the measures that are being taken to improve the quality of coal, and increase the efficiency and economy of grit-arresting appliances, but the society would like to see the latter used more generally in medium and small installations. The hope is expressed that the society's National Survey of the Sources of Pollution may provide more information on the extent of grit and ash emissions throughout the country. (APB)


After a 4-year campaign against the growing nuisance of "smog" to Los Angeles County, a newly empowered authority to combat the evil will avoid ordinary prosecution of establishments that pollute the atmosphere and will employ as its chief weapon injunctive proceedings designed to put such offenders quickly out of business. Other cities, the atmospheric problem of Los Angeles is not mainly one of coal dust and smoke but of industrial fumes. The accumulation sometimes reduces visibility to less than a mile and is extremely irritating to the eyes and nasal passages. Corrective measures have been blocked up to now by the multiplicity of jurisdictions in the county, which contains 45 incorporated communities, and by opposition from industrial concerns faced with big expenditures to suppress their fumes. Action by the last State Legislature, however, enabled the creation of a smog-control district embracing the whole county. (FA)


Subsidence due to mining and smoke abatement are discussed. Maps show location of gas and electricity undertakings. (FA)


A theoretical discussion of the mechanism of the purification of gases by activated charcoal. (FA)


Tall smokestacks belching clouds of black smoke once symbolized an active, prosperous industry. Today, the same black smoke bespeaks only inefficiency, since it is the product of incomplete combustion. For a long time industrial areas accepted smoke, dust, and fumes as a necessary evil, then numerous cities revolted against the smoke-filled atmosphere and passed smoke ordinances.

The three points of view to be considered in attacking the smoke problem are those of the plant owner, the employees, and the plant's neighbors. Examples are given of instances of air pollution from chemical plants and measures that have been taken to control emissions of smoke, dust, and fumes. The problem cannot be escaped by removing a plant to a remote locality. It must be faced. Installation of controls that may appear an unnecessary expense, often can result in a true economy.


Atmospheric pollution from industrial sources is divided into smoke, grit or fly ash, and sulfur oxide
gases; the occurrence of these nuisances is surveyed under the headings of electricity stations, gas works, iron and steel works, and miscellaneous undertakings such as collieries and clay and brick works. A more complete atmospheric pollution census, covering the whole country, would give material of value for the study of the extent of nuisances in specified industries and processes, the nature of such nuisances, their consequences, the difficulties standing in the way of their abatement, and the value of remedial measures already taken. (FA)


Factors to be considered in selecting power equipment for refuse disposal by incineration were discussed, including the requirements as to quality of area, primary combustion, secondary combustion and settling chamber areas, flame sizes, stack sizes, and heights for the various types of refuse to be consumed. (FA)


Memorandum of evidence submitted by the Society of Medical Officers of Health to the Domestic Equipment Sub-Committee of the Ministry of Health's Central Housing Advisory Committee, November 1946. For kitchen-living room types of house preference is expressed for openable stoves of modern types for the kitchen-living room, and, for separate living rooms, open fires burning solid smokeless fuel or gas or electric fires. For working kitchen, houses the back-to-back range such as the No. 3 Yorkdale is suggested. Bedroom heating by convection from this and with electricity or gas for topping up is favored. Among other points, mention may be made of the view that there is no case for a coal fire in a bedroom used as an occasional sickroom except where electricity or gas is not available. Wall or hopper ventilators are considered advisable in all bedrooms. (FA)


The point being taken by the various agencies concerned in the smoke-abatement problem is outlined. It can be safely stated that sufficient effort is being made by the smoke-abatement agencies, industry, and educational and research institutions to combat the smoke nuisance. However, their efforts can be better coordinated if a concerted effort is made to obtain better representation of the various consumers of fuel, coal in particular, in the membership of the Smoke Prevention Association of America—thus it would be possible to bring about a saner understanding of each other's objectives.


Atmospheric pollution is discussed with particular reference to Middlesbrough. (APB)


To comply with the requirements of the Coal Mine Refuse Act, 1936, it is necessary for refuse from mines to be tipped so that spontaneous combustion is unlikely. In one colliery in south Yorkshire all refuse is retained below ground in the colliery workings and none is brought to the surface. This is probably the best solution. Failing this, it is suggested that refuse be tipped in layers not exceeding 10 feet deep and consolidated as tippers are worked. Where great quantities of large lumps of coal waste are to be tipped, these should be crushed. The finished banks and sides of the tip should be overlaid and consolidated and covered with a layer of incinerable material. (FA)


Practical suggestions for improving the atmosphere of foundries, large and small, are given in a comprehensive survey of the foundry dust and fume control problem. Among the subjects covered are engineering problems, measurement of air contamination, salvage of existing equipment, air sources, outdoor air pollution, the smoke nuisance, and costs. (APB)

1948


The increased sale of anthracite stokers in America during 1945 is attributed to the enforcement of smoke regulations. (FA)


The use of cartoons in smoke-elimination work has been found helpful. Suggestive cartoons are given for cartoons that can be used by those who are not artists. Pictures taken from advertisements accompanied by catchy sayings can be worked into smoke-prevention posters. A number of such posters are described. Employees may be depended upon to supply ideas. When they do their names should be mentioned.


One chapter is devoted to smoke prevention. Domestic and industrial problems are reviewed, and there is a summary of the main effects of smoke. The importance of health education in smoke prevention is stressed, and an account of practice in the United States is included. (USPHS)


Smog regulations have been a concern of Los Angeles for a number of years, and the past decade has seen increased cooperation of scientists, industrialists, and city officials in solving the problem. In 1947, the Los Angeles County Air Pollution Control District was established by law to enforce corrective measures. At the time the scientists were called in, it was realized that strict enforcement of regulatory measures might be difficult, because: (1) Specific causes of smog were largely undefined; (2) standard methods of sampling and analysis had not been developed; (3) suggested corrective measures were often unsound; and (4) without a scientific background, public reform pressure would lead to unfair and ineffective courses. In the present program, local scientific and engineering advice is offered freely to enforcement officials and industrialists.

The consulting committees have consistently recommended a policy of sound basic research and engineering advice, full cooperation to help industry help itself, and avoidance of zealous overhauls that gives only half solutions. The plan of organization is explained and shown in a diagram. The main features are the Atmospheric Purification Committee, a Scientific Committee, a Process Consulting Group, committees within the industries, and a Joint Laboratory Research Group. The plan of handling suspected cases of smog production by members of a particular industry by the various groups in cooperation enables maximum results to be obtained with a minimum of friction, time, effort, and money. (FA)
CONTROL OF AIR POLLUTION


Smoke abatement has now reached the era where it must accept as its recognized duty the control not only of smoke but of all the other undesirable elements that may pollute a city's atmosphere. Each year more and more papers dealing with fly ash, atmospheric dust, fumes, and other aspects of air pollution not bearing directly on the question of visible smoke, appear on the program of the Smoke Prevention Association. The smoke-abatement engineer's horizons grow wider and wider. Contemplation of the many different kinds of pollutants in the air and the myriad of sources from which they emanate—many of them admittedly beyond control—is apt to lead to a feeling of frustration.

Reference is made to the many phases of the air-pollution problem that still require solution. Each is a separate phase requiring specialized knowledge and techniques. The value of each phase must be recognized. (10 refs. cited)


Fundamental information is given on economical ways and means for combating smoke as well as various dust nuisances. Also several examples are given of savings accomplished with proper firing equipment. Elements of adequate ordinances are discussed. "T-T-T" refers to time, temperatures, and turbulence; "M-O-T-T" to mixture, oxygen, temperature, and time. Two ways of expressing the essentials of complete combustion which are discussed. (APB)


An air-pollution committee has been appointed by the National Coal Association to initiate an educational campaign, with special emphasis on economical burning of solid fuels to eliminate smoke, and to deal with elements other than coal that are present causes of pollution.


A survey of the problem of dust extraction is presented, and the various systems whereby it can be employed on gasworks are outlined. (FA)


Discusses programs usually proposed for control of air pollution in cities. Specific reference is made to attempts to solve the problem in Cleveland.

Two main sources of air pollution are (a) from industrial processes and (b) from the combustion of fuel. It is believed that these can best be controlled by the following three avenues of approach: (1) Controlling pollution at its point of origin in the plants through a bureau of industrial hygiene; (2) controlling excess emission of pollution into the neighborhood through a bureau of industrial nuisances; (3) controlling smoke from an industrial, residential, or commercial source through a bureau of smoke abatement.

The following considerations are absolutely essential to the success of any air-pollution-control program: (1) The community must not be misled into believing that air pollution can be eliminated—it definitely cannot. All that can be done is to reduce its concentration to a tolerable level and to maintain it at that level. (2) There must be no thought of arbitrarily closing down violating plants; on the contrary, their cooperation must be enlisted to make them good neighbors and preserve good public relations. All industrial centers try to induce the influx of additional plants for the benefit of the community and not to drive them away.

There is no magic in air-pollution control but only hard work. Therefore, to be successful the program must be long-range, and any statement to the contrary is fallacious.

The program is costly, and unless the city administration is prepared to undertake it on a real long-term basis, the attempt had better not be made at all. Part of the cost may be returned in fees for permits and inspections.

The support and cooperation of the entire community, especially the newspapers, must be obtained. This is self-evident, as no law can be enforced unless it meets with the approval of the people upon whom it is imposed.

The enforcing agency must be staffed with career men sincerely imbued with the necessary civic spirit. A good law can be seriously impaired by poor administration.

The personal and material benefits that can be derived from a properly administered air-pollution-control program based upon common sense and fairness are many.


Subjects discussed briefly include: Stack-gas cleaning, winter air supply for industrial buildings; radiant-heat shielding and control; dust suppression by use of wetting agents; carbon monoxide in exhaust gas; exhaust ventilation for swing frameIders; conveying dust-laden air in presence of steam; stack-dust sampling; exhaust ventilation for welding. (FA)


Statistics are presented on sootfall in different locations in the area and in other areas, with meteorological data. The conclusions state in part: "The atmospheric pollution problem in this area is important enough to warrant serious consideration of plans for an overall and area-wide atmospheric pollution control program, not merely smoke abatement. Studies of the various gases, vapors, and mists in the air, in addition to the sootfall studies reported, would be highly desirable for future guidance. It is desirable that the records be continuous, so as to evaluate the beneficial effects of any improvements made and to furnish additional technical data for a scientific approach to formulating atmospheric pollution regulations. However, a definite goal should be established in order that the studies will yield the most value for money invested." (APB)


The Ministry of Fuel and Power assured that in all new coal-burning power stations the most modern methods will be used to prevent pollution of the air by smoke, grit, and sulfur oxides from the chimneys and by dust from the coal unloaded. Asked if the Battersea or Fulham conditions imposed by previous Governments will be imposed in all urban areas from the outset, the reply was that we should not be tied down to the introduction of costly gas-washing plants in all circumstances at all power stations. Generally speaking, however, these conditions will be imposed. (APB)


The Minister of Health was asked when the promise made on smoke abatement is to be implemented and whether he would call for a report on smoke pollution of the atmosphere and take early action to apply a
modern policy of smoke abatement. The reply to the first part of the question was—"When the legislative timetable permitted"—on the second part—"In spite of oppositions are already proceeding, and such action is being taken as is possible in the present shortage of materials." (FA)


The problem of gob piles is divided into methods of quenching fires that are active and methods of disposal that will prevent spontaneous combustion. The chemistry of spontaneous combustion is discussed with special reference to the part played by water. Methods of quenching fires by using water, clay and earth coverings, trenches, and lime and cementation process are given. The best method to build gob piles to lower risk of fires is given. (FA)


In recent years there are growing demands on industry for maximum efficiency in operation. Atmospheric pollutants may be in the form either of gas-borne particulate matter or of gases. The principles of absorption of gaseous substances are basic unit operations of chemical engineering, and absorption methods are well understood, even the quantitative application may frequently be difficult or costly. The work of tolerability is provided a basis for efficiency specifications.

Another part of the problem of improvement is entirely outside the realm of engineering but of equal importance to it. It cannot be denied that atmospheric pollution has important psychological aspects, which is not intended to imply that they are unreal. It is therefore of great importance when engineering works are undertaken, complete information on their significance be furnished by management to the community. Without such an information program, coupled of course with engineering accomplishment, much of the benefit in the furtherance of good community relations is lost.


A plea is made for a more effective policy for preventing atmospheric pollution. (FA)


A letter to the Editor states: In announcing on May 19, 1947, that oil, not coal, would be burned in the Bankside Power Station, and that a gas-working plant would be installed to eliminate sulfur, the Lord Chancellor said: "If we find that there is a danger that these difficulties may not be surmounted, then I agree that is a real argument against the scheme. In our discussions I was told that sulfur could be effectively eliminated. I agree that this is a sine qua non of the scheme." On May 5, 1948, the Minister of Fuel and Power, asked whether he could confirm the above assurance, replied, "Yes." As late as September 23 last, in answering a question of which due notice had been given, he did not challenge a statement therein that the Government was pledged not to proceed unless oil fuel was found not to be harmful to buildings nearby. He added that the result of the promised test of methods of eliminating sulfur would not be available before spring. On November 18 the Minister would not promise that if no way was found of making the fumes harmless to St. Paul's the project would be abandoned. Thus repeated and unconditional ministerial guarantees have been thrown overboard, and those whom they thrilled into a sense of security have now to be content, "because of the increasingly urgent need for new generating capacity", with an assurance that "there is no doubt about the practicability of eliminating the fumes." (FA)


The Minister of Fuel and Power was asked on what grounds the erection of the new Bankside Power Station had been proceeded with when the results of the tests being undertaken to discover whether it would emit fumes harmful to the fabric of nearby buildings would not be available till early next year. The reply was that, as the Minister of Town and Country Planning explained last year, the Government's technical advisers are satisfied that harmful sulfur fumes can be efficiently and effectively eliminated. The tests on the pilot plant are solely for the purpose of selecting the most efficient method of gas washing. In view of the increasingly urgent need for new generating capacity in London it is only sensible, therefore, to proceed as quickly as possible with the erection of those parts of the station that will not be affected by the type of gas-washing plant it is decided finally to install.

The Minister was asked whether he would give a promise, in accordance with the previous pledge in the House, that if no way was found for making the fumes of these oil burners at the fabric of St. Paul's the project would be abandoned? The Minister of Town and Country Planning made it perfectly clear that there is no doubt about the practicability of eliminating the fumes and that it was only a question of the best way of doing this. As the Minister's statement was a flagrant breach of the Government's promise the Minister said he would raise the matter later. (FA)


This second annual report of this organization covers a period of intense activity and expanding function. It had been demonstrated that the Air Pollution Control Act had been soundly conceived and that the regulations were enforceable, although some additional regulations were found necessary. The functions of the district include inspection, engineering, and research. The inspection division has been active; nearly 20,000 inspections have been made, and more than 2,500 improvements in fuel disposal, etc., have been carried out as a result of recommendations. These include use of diesel engines, elimination of exhaust smoke from trucks, and better inclination of refuse. An important feature of the work of the engineering division was the development of new standards on dust and fumes. An outstanding example of new installations for control of contamination is the Hancock Chemical Co. plant for the production of elemental sulfur from hydrogen sulfide recovered from refinery gases. Experiments have been conducted, and some practical results have been achieved with several methods of air purification. Many mechanical and chemical improvements have been suggested and adopted. The research division has been concerned with determining the source of eye irritation and of limited visibility. The study of these problems has involved collection and analysis of numerous aerosol samples. The loss in visibility has been found to be correlated with sulfur dioxide content of the air. The eye irritant has not been definitely identified, but the movement of the air in which it occurs has been studied. A change has also been found associated with smog, and the problem is being studied. The research program will be intensified by the use of additional methods and locations of sampling. It is expected that in another year and a half very decided improvement in air conditions will result from the integrated program. (HHD)

The speaker claimed that, in planning educational measures to attain clean air, two groups of people, stokers and housewives, particularly the housewives of tomorrow, should be approached and that a policy of fuel efficiency was closely linked with the one advocating smoke abatement. (APB)


The essentials of good combustion—correct time, temperature, and turbulence—are discussed in relation to the most commonly used fuels, gas, oil, and coal, and various firing equipments, including both overfire and underfire stokers. (APB)


The very desirable goal of reduction of atmospheric pollution in cities is sometimes confused by entrance of a local citizen who is hungry for the voices of groups of citizens urging improvement but almost totally ignorant of scientific means of smoke abatement.

The usual result of a condition of this kind is to make the problem more difficult. The reduction of atmospheric pollution is a long-range program that must be tied in with city planning. To conduct a program properly, industry either must take the initiative or competent civic-minded engineers must cooperate with municipal authorities in setting up the program. Once set up, the program must be guided constantly by citizens who are qualified by experience to cope with the problems that arise. The Coal Producers Committee for Smoke Abatement has surveyed a number of cities and presented their findings to citizens boards. Their findings of many defects in industrial plants and their recommendations for improvement are reviewed at some length. The development of a smoke ordinance in Erie, Pa., and establishment of an Industry Board along the lines recommended in this paper are described. (FA)


The effectiveness of the standard Pease-Anthony water scrubber can be increased by adding finely atomized spray to the dirty gas close to the gas inlet, producing the effect by passing the gas at high velocity through a Venturi throat into which the liquid was suitably ejected. A description is given of three full-scale installations. (APB)


This is a report on the progress made in Pittsburgh's Smoke Abatement Program at the Pittsburgh works of the Jones & Laughlin Steel Corp.

After reviewing the history of the smoke nuisance in the early days of Pittsburgh, the developments in effecting smoke abatement by the company mentioned are outlined.

Smoke abatement in the steel plant does not end with eliminating smoke from the stationary boiler stack. There are other smoke and dust problems to be solved. The river boats and narrow-gage locomotives are two smoke sources that continue to require close attention.

A number of industrial plants are located in Allegheny County. Without the support of the county, the territory surrounding Pittsburgh proper, the ultimate goal of a cleaner and healthier community cannot be achieved.

The work is described of committees made up of representatives of industry and public-minded citizens in preparing smoke regulations and determining methods for abating smoke and industrial gases in the surrounding territory.

With the city of Pittsburgh ordinance of 1941 fully in effect, the smoke-abatement program is well along the road to success.


The speaker recommended that all new fuel-burning plants, other than domestic appliances, should be approved by the local authority before being installed or operated. (FA)


An account is given of a discussion between officers of the National Smoke Abatement Society and representatives of the British Electricity Authority on August 6, 1948, on the policy of the authority with regard to the emission of grit and sulfur in the flue gases from power stations. It is made clear that the authority is prepared to take every practical means to eliminate the emissions. Mechanical grit arrestors are being installed at Battersea and Fulham; gas-washing plant for removing sulfur will be installed at the new Bankside station; in new stations provisions are made in the layout of the plant for the subsequent incorporation of a gas-washing plant should this prove to be necessary when the station is in operation. (APB)


The work of the Coal Producer's Committee for Smoke Abatement is reviewed. It is stressed that abatement of smoke will not completely clear the atmosphere over any industrial city, for a good part of the pollution comes from industrial fumes and exhausts, waste disposal, building construction and destruction, exposed soil surfaces, and just plain dust. The findings of the Chicago Association of Commerce from a comprehensive research to correlate other factors with dustfall collections are quoted in support of this. (APB)


Selecting Columbus, Ohio, as its guinea pig, the Coal Producer's Committee for Smoke Abatement has embarked upon a cooperative program of practical assistance to city smoke-control authorities and coal consumers. (FA)


This report on an investigation of the nature and origin of smog in the Los Angeles County area, covering the period from June 2, 1947, to June 2, 1948, shows progress that has been made towards the solution of the problem, especially in these three points: (1) Development of the Stanford Research Institute smog index; (2) evaluation of a forecasting method, predicting smog-free days with considerable certainty and smoggy days with at least 50 percent accuracy; and (3) preliminary laboratory tests of a number of suspected eye irritants that may be present in the smog, and development of methods for detecting and measuring low concentrations of these and other compounds in the atmosphere. (FA)
Discusses some causes of the smoke nuisance and the factors essential for the prevention or control of smoke when burning bituminous coal. (FA)
1919
2041. ANTHRACITE INSTITUTE BULLETIN. Anthracite Institute Establishes New York Smoke Prevention Clinic. 1949, p. 1.
The clinic will provide information on three methods of solving smoke problems: (1) By instruction in proper firing methods, with no change in equipment or fuel involved; (2) by using admixtures of solid fuels; and (3) by changes in fuel and equipment. (FA)
Pres. at Ind. Wastes, 14th Ann. Meet.
The blame placed on industry for its share of air pollution has resulted in a large measure from our industrial development and the resulting great concentrations of industry.
When wood was the common fuel, chimney gases were of minor importance. However, the advent of coal as a basic fuel presented many new problems. Oil and gas were supposed to be perfect fuels, as there was no ash and they could easily be burned without smoke, but we have found that the products of combustion of even these fuels have objectionable ingredients.
Regardless of the relative amount of industry's contribution to air pollution, industry must accept its due responsibility and through continued effort and research must find ways of eliminating the nuisances it has created—public opinion demands it.
In addition to each industry studying its own particular problems, it is going to be necessary for each community to study air conditions from a standpoint of health and of public good.
The public-relations problems incident to smoke regulation or air-pollution control are discussed. The departments, administrators, and ordinances under which control agencies operate are brought into existence by a great demand for relief from smoke and air pollution by the people who are an active source of support. The great problem is to keep alive the desire of the people for air-pollution and smoke control, not with a sense of dissatisfaction but of understandable appreciation of what can be done.
Describes organization, personnel, methods of operation, and detailed accomplishments of National Fuel Efficiency Program.
Experience in dealing with domestic smoke and with high- and low-altitude emissions from vertical steam boilers, iron foundries, coal-fired annealing ovens, installations burning pulverized fuel, stone quarrying, leather buffing, etc., is discussed. Since February 1948, the Public Health Department has included full-time specialist staff to carry out the work of the smoke abatement and inspection of factories. Two methods of attack have been found effective: (1) To invite attendance of persistent offenders at a meeting of the Health Committee to show cause why they should not be prosecuted; (2) to investigate methods of firing at offending premises for continuous working periods of 6 hours on 2 consecutive days, noting errors of technique on the first day and commenting on them on the second. Future policy of the Department includes further practical work among stokers and furnace men, consultations with works engineers and managers. (APB)
Elimination from the atmosphere of foreign and sometimes harmful gases, liquids and solids is becoming a major activity. Air-pollution control comprises (1) eliminating existing sources of pollution and (2) preventing the creation of new sources of pollution. The Labor Department's Division of Industrial Hygiene and Safety Standards, through its activities in control of dust, toxic concentrations, and gaseous discharges in industry, has acquired extensive knowledge on the subject of atmospheric pollution. Atmospheric pollution control means considerable savings to health and property. (FA)
The objectives of the industrial hygiene department include protection of employees of the company and of others using the company's products and prevention of air pollution. Industrial hygiene is a function of the central medical department, and there is perfect liaison with all central departments, and their employees. Cooperation with the legal, safety, and sales departments is vital. Through the last, customers are informed of potential toxicity of products and preventive measures. The industrial hygiene department translates toxicological information into terms understandable by supervisors and employees. The work is largely preventive than corrective. The recommendations of the department are used by the engineering department in plant design. The atmospheric pollution is prevented by careful control and by frequent air sampling, usually on a micro scale, at all vents where injurious effluents may escape. Excellent cooperation between all departments involved has made the program highly successful. (IHD)
Proposed antipollution measures at the plant of Albright and Wilson are described. Dust nuisance caused by tipping in the open-air wagons containing phosphates will be remedied in the future by the erection of a cover with movable doors to form a tipping room. A gas nuisance arises in the phosphorus-recovery plant where sludge containing phosphorus is dried in an electric furnace. If the lid is removed, as, for example, to renew an element, the unfinished product, a white gas, escapes into the atmosphere. Large-scale experiments are being carried out at the firm's Oldbury factory to eliminate this nuisance. (FA)
The Delta Engineering Co. has developed a catalytic process of combustion, using catalysts essentially of the terpene hydrocarbon series. These are transported into the reaction zone by means of a small quantity of low-pressure steam with the secondary air. The catalyst actually promotes the separation of the combustion gases and promotes combustion at a much lower temperature. The catalysis changes the flame from a long reddish orange smoky one to a short intense dazzling white flame having quite a different sound from the original. The process may be installed
in any type of boiler, and can be applied to heavy oils and sludge as well as bituminous coals and sawdust. (APB)


Several approaches to the elimination of odors and the control of effluents from the Kraft paper mill are noted. A correct solution of the problem will depend upon local conditions and the attitude of the community as well as the willingness of management to institute measures to eliminate odors and control waste effluents. (IHJ)


Comments are made on the growing menace of smoke and soot, in South African cities, which emanate from domestic and industrial chimneys and from badly stoked steam wagons. Careless stoking is believed to be responsible for a large proportion of unnecessary smoke. Methods suggested for attacking the problem are: (1) Education of public opinion to awareness of the existence of pollution; (2) granting of closely defined pollution zones to local authorities; and (3) creation of an organization to give practical advice on better combustion and smoke prevention. (IHJ)


Discusses the development of cupola suppressors to overcome the problem of wood smoke and coke smoke and soot from vertical smelting furnaces. The heat recovery type of hot blast equipment, and a combination of cupola, boiler, and blast air heating units, can help prevent smoke, fumes, and dust emission. Wood smoke can be eliminated by the use of electric, gas, or oil igniters for the coke bed. Stack-gas igniters and oxidizers can be attached to the cupola to burn CO-containing gases. A washer for arresting at least 90 percent of the solids can be attached to the top of the cupola. (APB)


Contaminated waste air has been treated with a baffelate scrubbing tower with 42 plates in 3 stages. The air was sampled for activity before and after each stage, and the effect of several process variables was investigated. With only 6 plates per stage in use, the efficiency for plain cold water washing was 99.6 percent or better, and was 99.92 percent for the "cloud chamber" mode of operation, which utilized fogging on radioactive particles to increase the size. Some data on particle size and preliminary engineering figures are given. (IHJ)


At the request of the Minister of Fuel and Power was asked whether, in view of numerous complaints by the local inhabitants of the serious emission by the Greenwich power station of the London Transport Executive and of the danger to their eyes and nuisance to the children in the nearby schools in Old Woolwich Road, he will take steps to see that this power station is supplied with better quality coal in order that grit emission may be reduced and the conditions made more comfortable for the people in that district. The reply was that the emission of grit at power stations is not necessarily attributable to the quality of coal consumed, but an expert of the department is going to investigate to see what can be done to reduce any cause for complaint. (FA)


Discusses the basis for understanding just what air pollution is, how to measure it, and how to interpret the measurements. All pollutants are segregated into three broad categories: (1) Pollutants affecting human health; (2) pollutants affecting plant life; (3) pollutants causing corrosion of metals.


Preventive measures taken by private industries in Southern California are discussed in general and specific reference is made to installations in industrial plants. Mention is made also of the problems faced by industries in Oregon and Washington, where the claims have been made that fluoroine fumes are injuring live-stock and crops. (USPHS)


Methods which have been used to reduce atmospheric pollution are discussed with special emphasis on what is being done in the Los Angeles district. Rubbish disposal problems have been solved by using sanitary fill dumps and large smokeless incinerators. Odors from processing factories have been reduced by temperature control and closer supervision; fumes from nonferrous metal industries have been reduced by using a molten slag heavy enough to suppress them and also by the installation of bag houses. Procedures that have been adopted in the oil and chemical industries for reducing SO2 emission are outlined. (APB)


Solid fuel, but more specifically bituminous coal, is and will continue to be the basic source of energy for our industrial production and for heating our homes. As coal plays such an important role in our modern economy, it is natural that those charged with the responsibility of abating air pollution should be interested in what the coal industry is doing on smoke abatement. The coal industry not only recognizes its civic responsibility but has a well-organized program that is cooperating on projects to meet the objectives of the Smoke Prevention Association of America. This program may be divided into two general classes of activity: (1) Research in the improved use of bituminous coal, and (2) field activities to promote improved performance of existing equipment and encourage the commercial production of the industry's developments. The smoke-abatement work being carried on by the various coal companies as well as those burning the fuel is discussed in some detail and various types of improved coal-burning equipment are described. Continued public acceptance of coal depends on smokeless burning which encourages continuance of research and field studies by the coal industry toward adequate and proper smoke abatement. (7 refs. cited)


The general aspects of air pollution are presented. Causes of failure to control atmospheric pollution in
AIR POLLUTION—A BIBLIOGRAPHY

the past, such as incorrect estimate of the kind and size of the job, cost, and obstructive tactics of industry and others of the community who shared the view that smoke and dusts were the wages of a prosperous industrial community.

Reasons why air-pollution control should succeed are likewise outlined. The great increase in industrial production during the past 10 years, which will continue, means more airborne wastes will be produced. These will reach objectionable levels of contamination in many communities forming a compelling reason for doing something about atmospheric pollution.

The health aspect is a more potent appeal for control of atmospheric pollution than duty or the money-saving aspect. A promising indication of success is the many conferences sponsored by or contributed to by industry that have been held within the past year for studying ways and means of control.

Some of the legal aspects of atmospheric pollution are considered and reference is made to House Resolution 6352 to authorize and direct the Civil Aeronautics Board to study the need for smog control in the vicinity of airports to promote safety in air navigation. (5 refs. cited)


Outlines investigations carried on at the Fuel Research Station dealing with domestic appliance testing using the calorimeter building, smoke emission from boilers, atmospheric pollution, and deposits on boiler tubes. (FA)


The fuel requirements of the steel industry are discussed. Methods for preventing pollution of the atmosphere by the various operations connected with the production of steel are described. Although much time and money are required to solve the problem real progress is being made in its solution.


Existing confusions about ways to curb smoke and dust from power-plant stacks should be faced. The confusion is general and includes all engineers, and it is safe to say that nobody has yet found the best answer to this national problem.

Even the health angle is not understood. Much has been published about smoke as a menace to health. Yet an authority on industrial health says this of smoke: "There can cause specific diseases or death to any considerable degree cannot be stated in the light of available evidence." It is better to succeed moderately in a reasonable smoke and dust program than to attempt the impossible and accomplish nothing. Many communities have had fair success in reducing visible smoke by simple old-line rules based on the Ringelmann chart. The Ringelmann chart may be old fashioned and unscientific, but politically it is the most practical smoke-prevention device ever invented because it is cheap, requires no costly testing, and labels the offender for all to see.

Stopping dust is a very difficult matter. Ordinances specifying how much dust a stack may discharge per thousand pounds of fuel gas probably have value for the new large utility and industrial plants that can bear the burden of the costly dust sampling.


Claim 1: A separator for removing entrained solid particles from gas. An apparatus which comprises three vertical concentric vessels, the inner vessel open-ended at top and bottom, the top opening constituting a gas-discharge outlet, the two outer vessels closed at the top and tapered at the bottom to form restricted bottom openings in the respective vessels, the openings in spaced relation below the bottom opening of the inner vessel, an inlet connected tangentially into the upper portion of the intermediate vessel for introducing gases and entrained solids to the space between the inner and intermediate vessels, an outlet for the removal of solids at the bottom of the outer vessel, and slotted passageways in the walls of the inner and intermediate vessels for removing solids from the gaseous materials passing respectively therethrough. (FA)


Discusses what is being done by Jones & Laughlin's Pittsburgh Works. (FA)


An abridged version of the presidential address to the National Smoke Abatement Society which gives the recommendations of the Simon Report of 1946 for the reduction of domestic smoke and the proposed future policy of the society. (APB)


Describes the origin, production, preparation, and characteristics of solid smokeless fuels. (APB)


Devices for removing dust and fume from gases manufactured for industrial use are described and illustrated. These devices are classified under the following five headings: (1) Baghouses and filters, (2) washers and scrubbers, (3) centrifugal collectors, (4) electrical precipitators, and (5) ultrasonic agglomerators. (11 refs. cited)


The aim of educational and publicity work is to create strong public opinion for smoke abatement and elimination of other forms of atmospheric pollution. The progress that has been made in the last 20 years, and particularly since 1945, is attributed to the pioneering work of the Ministry of Fuel and Power, and to linking of the Department of Scientific and Industrial Research and Atmospheric Pollution Division with the Fuel Research Station at Greenwich. Discusses the parts that could be played in education and publicity work by local authorities, architects, teachers, industrialists, stokers, and householders.
CONTROL OF AIR POLLUTION


An attempt has been made to assess the magnitude of the various dust problems, directed mainly at the sources of dust and prevention of dispersal. A table classifying these problems is given. (FA)


Gives results of Bureau of Mines tests to determine best coals suitable for burning in three types of small stokers and comparative tests with hand-fired coal and with oil as fuel. Describes work done in cooperation with College of Mines, University of Washington.

1950


A smoke-abatement scheme and code of requirements for industrial boiler plant devised by Salford Corp. are summarized. (APB)


Revision of Bureau of Mines Information Circular 7000, Some Fundamentals of Smoke Abatement, with inclusion of developments to date. The Proposed Standard Smoke Ordinance prepared by a committee of representatives of the American Society of Heating and Ventilating Engineers, the Stoker Manufacturers Association, the American Civic Association, the American Society of Mechanical Engineers, and members at large is quoted.

Abatement of smoke at individual plants is discussed. However, regardless of equipment, the project of successful smoke abatement ends with the human factor. The operators must be trained to handle their particular equipment, and owners and operators must become enthused with the idea of abating smoke and fly ash. City air-pollution abatement is a long, hard problem requiring the expenditure of funds, continuing pressure, and work year after year.


Coal producers, district secretaries, and leaders in air-pollution control from all parts of the country discussed smoke-abatement activities, the relationship of smoke to the markets for coal, and the accomplishments to date by the coal industry in solving the problem.

The Coal Producers Committee for Smoke Abatement reported service rendered to 175 cities during the years since the war. Of particular interest were the reports on the progress in air purification in Columbus and Cleveland, Ohio, by the administrators of the control ordinances in those cities. It was explained that results were achieved without restrictions of any kind on the use of fuels. A 40-percent drop in dustfall was reported for Cleveland since inauguration of the control program.


The steel industry has begun a new program for studying the formation by steel plants, with $20,000 to be spent over the next 6 months. Study is being launched by the Industrial Hygiene Foundation at Mellon Institute and sponsored by American Iron and Steel Institute. Results of preliminary research will determine whether a concerted effort by the steel industry is needed, and along what lines. Electric precipitators for dust particles are used by some plants. Elsewhere coke-oven doors are equipped with "smoke sleeves" to prevent usual discharge of smoke when coal is put in. At least one plant has switched from steam to diesel locomotives.


Reports a survey of air pollution by the Coal Producers' Committee for Smoke Abatement presented on January 26, 1950, which recommended that mayors of political subdivisions organize a general committee to study air pollution and ways to abate the smoke nuisance.

It was pointed out that the combination of man-made pollution and industry-created smoke and fumes made the Kanawha Valley problem especially hard to solve.

The committee also warned that the air-purification costs for some plants would be high.


Considerable effort has been devoted by C. B. U. R. A. to finding methods of burning bituminous coal without making smoke. The work has included research on the mechanics of combustion of bituminous coal, and the factors that affect the production of smoke in closed fireplaces.

Adding certain gases to the air passing through the fuel under conditions of forced draft, greatly reduced formation of soot particles. Carbon dioxide, nitrogen, and water are useful in this respect and all of them are constituents of flue gases. Work on systems of recirculating the flue gases through the fuel bed is now progressing.

The applications of this work are not confined to its use in domestic appliances. The recirculation may be more practical on large appliances. It has a marked effect in reducing the amount of sulfuric acid produced and the overall amount of deposit formed in the cooled tubes exposed to the combustion gases. A full understanding of the effects of recirculation is likely to have far-reaching results both in design of appliances and the efficiency of their operation.


Speaking at the annual conference of the National Smoke Abatement Society, the director of the Coal Utilization Joint Council said that people wholeheartedly the smoke-abatement campaign and was anxious for practical progress to be made. However, a note of warning should be sounded lest the smokeless-zone movement outrun the fuel-supply situation.

Domestic smoke could be eliminated in three ways: By extending the use of gas or electricity, using solid smokeless fuels, or burning bituminous coal smokelessly. It was recognized, however, that it would be impracticable for gas and electricity to supply the whole domestic load in smokeless zones. Moreover, it would be at direct variance with government policy, which was that in the national interest the main winter domestic heating and hot water loads should be borne by solid fuel.

Of a total domestic consumption of some 35 million tons of solid fuel a year, only 6 million tons was at present smokeless solid fuel, and the remainder was bituminous coal. The council had been given to understand that for the next 5 years or so, there would be little hope of additional supplies of the natural smokeless fuels, and although it appeared that there was a prospect of a limited increase in the supply of carbonized smokeless fuels, it was only likely to be a few million tons.
With this great gap between the possible supply of smokeless fuels and the total domestic demand, it would seem that the ultimate solution to the problem of domestic smoke abatement lay in the direction of the progressive development of appliances capable of burning bituminous coal with less and less smoke. The evidence available at the present stage of research, however, of the burning of bituminous coal smokelessly in the open grate was not likely to be achieved for many years.

The council's fear, therefore, was that if a general movement developed to establish smokeless zones throughout the country, there would be neither enough solid fuels nor appliances capable of burning bituminous coal smokelessly to meet the demand. As a result, the smokeless-zone movement might well be discouraged. If the present solid fuels were to be used to the best advantage in the interest of smoke abatement, it would be better if certain of the new towns or redeveloped areas declared their intention of being "cleaner air" zones.


Experience gained by the American Smelting & Refining Co. at Tacoma and 140-ton contact acid plants at Galuch and 100-ton and 150-ton plants at Garfield between 1942 and 1950 indicated that a well-designed contact plant can operate efficiently with a continuous supply of uniform 3.0 percent gas, but installation cost is very high, making a reasonable commercial return rather doubtful. Absorption processes that have been patented and placed in commercial operation include: (1) American Smelting & Refining Co., 1919, which operated on 7-percent segregated converter gas using a modified Hanish-Schroeder process with water as absorbent; (2) Metallgesellschaft, A.G., using xylidine in water for an 8-percent gas from cement kilns or 3.5-percent converter gas; (3) Imperial Chemical Industries, using basic aluminum sulfate for 5-percent gas from upper smelter; (4) Falconbridge Nickel Co., using anhydrous dimethylamine for 3-percent gas from roasting of nickel-copper matte; (5) American Smelting & Refining Co., 1947, using an improved dimethylether process in which 98-percent recovery of liquid sulfur dioxide is obtained from 5.5-percent sinter gas; (6) Consolidated Mining & Smelting Co., Trail, B. C., using ammonium for weak gas from lead plant and 7 percent gas from zinc roaster. Suggested outlets for disposal of liquid sulfur dioxide include the chemical and paper industries, sulfureic acid manufacture, and elemental sulfur manufacture by reduction with carbon monoxide or methane or reaction with hydrogen sulfide. (APB)


Sampling methods and ragweed-control programs are discussed extensively. (IHD)


Considers (1) the principles involved in air-pollution abatement, (2) the dispersion characteristics of atmospheric contaminants, (3) the steps to be taken for the solution of the problem, and (4) samples of recommended methods.

The first principle is that top management must establish a clear-cut policy to the effect that where pollution is known to exist, it will be abated to a satisfactory level. The second principle is that smoke is usually abated for public relations reasons because it usually does not result in adequate, if any, financial benefit. The third principle is that fundamentally there are only three ways to correct a pollution problem—design the process to eliminate production of the waste, install equipment to collect the waste at the source, or obtain better dispersion of the material in the atmosphere. Examples of these various methods of solving the problem are given.

The concentrations of concern in connection with dispersion in the atmosphere are time average at a point—hours; average during pollution at a point—minutes; absolute peak at a point—seconds.

The seven steps to a solution of the pollution problem are: (1) Determination of the presence or estimated levels of pollution; (2) determination of acceptable levels of pollution; (3) determination of degree of improvement required; (4) selection of abatement or treatment method; (5) effecting the installation; (6) testing to determine results; and (7) publication of accomplishments to get credit due.


Developments in the United States in 1950, chiefly newspaper campaigns, are reviewed. The tendency to demand comprehensive legislation without knowledge of the facts is deplored. The following long-term program is suggested: (1) Determination in each local area of the extent of pollution, the kinds of pollutants and their sources, and the ability of the air to absorb them and winds to disperse them; (2) establishment as a fa-t whether any of the pollutants found in the area is hazardous to human life or detrimental to property, alone or in combination; (3) ascertainment of the extent to which each of the pollutants found in substantial quantity—whether hazardous or simply unpleasant—can be reduced economically. (APB)


Describes the various types of air-cleaning devices installed in an electronic tube plant. This installation was made to reduce product damage from atmospheric pollution from both inside and outside the plant. To reduce the load on the cleaning units, operations creating large amounts of pollution were isolated and exhausted to the atmosphere. Low-velocity cleaning areas had their air recirculated partly or entirely, depending on the load conditions of the air-conditioning unit. The best procedures are mentioned for sulfides and total dust, which were determined before and after installation. Satisfactory conditions resulted for electronic tube manufacture. (APB)


Pollution control is dominated by economic considerations. Technically any degree of control is possible. Contaminant dispersion by using stacks has a number of limitations. Various contaminant collection systems are discussed. Cyclone or centrifugal separators are useful down to particle sizes of 5 microns. Gravity settling chambers are generally most practical when particle size exceeds 43 microns. Electrical precipitators are probably the most versatile of all dust or mist collectors. They are very efficient for collecting particles smaller than 0.1-micron diameter. Air filters entail high head losses and sometimes must be cleaned too often. Impingement separators have low efficiency for small particles. The use of high-frequency sound waves to effect the agglomeration of fine particles is one of the most recent developments.
ADEQUATE DILUTION OF AIR POLLUTANTS AND EFFICIENT MEANS OF SMOKE TREATMENT WOULD ALLOW SMELTERS AND FARMERS TO OCCUPY ADJOINING AREAS WITHOUT STRIFE.

EXTENSIVE RESEARCH SHOWS THAT STACK HEIGHT AND TEMPERATURE OF EXIT GASES MAKE A DIFFERENCE IN DILUTION OF THE CONTAMINANTS.

DOUBLE STACK HEIGHT IS SAI'D TO REDUCE GROUND CONCENTRATIONS TO ONE-FOURTH, TREBLING IT REDUCES TO ONE-NINTH, AND INCREASING IT FOUR TIMES REDUCES TO ONE-SIXTEENTH OF THAT FROM THE ORIGINAL STACK.

HONEYWELL INSTRUMENTATION DATA SHEET: SMOKE PREVENTION PLUS COMBUSTION CONTROL CUTFUEL COSTS. NO. 10.14-4, 1950, 3 PP.

THE HAZEGAGE INSTRUMENT MEASURES THE INTENSITY OF SMOKE BY MEANS OF A PHOTOELECTRIC UNIT INSTALLED IN THE CHIMNEY. THE SMOKE DENSITY IS RECORDED ON A CHART EITHER WITH A FULL RINGELMANN SCALE OR ONLY FROM NO. 2 RINGELMANN. THIS UNIT CAN ALSO BE USED AS A COMBUSTION CONTROL ELEMENT REGULATING THE FUEL-AIR RATIO IN RESPONSE TO THE OPTICAL CHANGES IN THE WASTE GASES. (AFB)

INDUSTRIAL HYGIENE NEWSLETTER. SCHOOLS AND PLANTS ASK FOR HELP ON AIR-POLLUTION PROBLEMS. VOL. 10, 1950, NO. 5.

WITH THE SEARCHLIGHT OF PUBLIC OPINION DIRECTED TOWARD AIR POLLUTION, NEW YORK ENGINEERS HAVE HAD AN INCREASING NUMBER OF REQUESTS FROM SCHOOLS, PLANTS, AND COMMUNITIES FOR HELP IN CLEANING THE AIR OF INDUSTRIAL POLLUTANTS.

ENGINEERS AND CHEMISTS OF THE DIVISION OF INDUSTRIAL HYGIENE AND SAFETY STANDARDS, NEW YORK DEPARTMENT OF LABOR, HAVE HAD EXPERIENCE IN A WIDE VARIETY OF PROBLEMS IN THIS FIELD. MOST OF THIS WORK IS LIMITED TO GIVING ASSISTANCE ON REQUEST ONLY.

SURVEYS WERE MADE OF PLANTS MANUFACTURING INSECTICIDES AND GLASS TO DETERMINE THE NATURE OF THE EFFLUENTS COMING FROM THE STACKS AND TO ADVISE WHETHER SCHOOL CHILDREN WOULD BE SAFE IN SCHOOLS BUILT IN THE VICINITY. IT WAS AGREED THAT THE DISCHARGE OF ALL CONTAMINANTS FROM THESE PLANTS COULD AND WOULD BE PROPERLY CONTROLLED.

A DISTINGUISHED INTRON OF INDUSTRIAL HYGIENE AND SAFETY STANDARDS WAS ASKED TO ASSIST A PLANT EXHAUSTING HYDROFLUORIC ACID MISTS INTO THE ATMOSPHERE OF THE NEIGHBORING COMMUNITY.

A WOOD-WORKING PLANT WAS AIDED IN THE ELIMINATION OF WOOD DUST AND PVC DUST IN NEW YORK STATE WERE PROVIDED WITH ASSISTANCE IN DRAFTING LEGISLATION AND ADMINISTRATIVE REGULATIONS TO CONTROL THEIR AIR-POLLUTION PROBLEMS.

DUST FROM TAILINGS DUMP CAUSES TROUBLE. VOL. 10, 1950, NO. 12.

AN INTERESTING CASE OF ATMOSPHERIC POLLUTION STUDIED BY THE COLORADO STATE DEPARTMENT OF PUBLIC HEALTH HAS PRESENTED SOME VERY UNUSUAL SUDDENNESS. THIS CASE INVOLVES A TAILINGS DUMP FROM A LARGE MILL THAT HAS BEEN IN OPERATION PRODUCING GOLD AND SILVER ORES FOR A NUMBER OF YEARS. THE ACUMULATED WASTES COVER 57 ACRES AND ARE ABOUT 300 FEET THICK. IT IS ESTIMATED THAT THERE ARE 10,000,000 TONS OF THIS ASH IN DRY WINDS AND DURING DRY AND WINDY SEASONS. MILLIONS OF TONS OF DUST ARE BLOWN OVER COLORADO SPRINGS.

THE COMPANY MOVED THE MILL LAST JULY, BUT IS STILL CONCERNED WITH THE PROBLEM ON ITS PROPERTY AT COLORADO SPRINGS. SEVERAL UNSUCCESSFUL ATTEMPTS WERE MADE TO CONTROL THIS DUST, AMONG WHICH WERE ADDING CEMENT TO THE SLURRY BEFORE IT IS DEPOSITED ON THE DUMP AND USING OIL. THESE EFFORTS WERE OF NO VALUE AND A SYSTEM OF DUSTING WATER WAS INSTALLED, WHICH WAS ONLY PARTIALLY SUCCESSFUL.

WORK IS RAPIDLY PROGRESSING ON COVERING THE WHOLE AREA WITH FROM 1 TO 3 FEET OF DIRT FROM THE SURROUNDING HILLS. GRASS SEED HAS BEEN IMPORTED FROM AUSTRALIA THAT WILL GROW UNDER ARID CONDITIONS AND WILL BE PLANTED EARLY NEXT SPRING. IT IS HOPEFUL THAT THIS WILL SOLVE THE PROBLEM PERMANENTLY AND THAT AN ADDITIONAL WORK WILL BE NEEDED.

The chairman of the National Coal Board opened the first postwar exhibition of the National Smoke Abatement Society on Fuel Efficiency in Industry and Home at Manchester. He assured his audience that the National Coal Board was in full agreement with the aims and objects of the society, and user, as well as the householder, must use his fuel efficiently and with as little smoke as possible.

Industry's demand for coal was increasing; in the first 50 months of the year, the consumption of coal by industry and public utilities increased by 3.8 million tons over that for the same period last year. Unfortunately, the production of coal was not rising proportionately. It will be difficult to meet the demand at home and abroad and is, therefore, urgent that industry at home should improve its methods of using coal. Greater efficiency ought to mean less smoke.

PROBLEMS WITH FIRE BREAK OUT IN ABANDONED SPOIL BANKS DISCUSSED IN THE LATEST QUARTERLY REPORT OF THE CHIEF ALKALI INSPECTOR FOR SCOTLAND. "OWNING TO THE INCONSISTENT PRACTICE OF INDIFFERENT TIPPING, IT HAS BEEN DIFFICULT TO DETERMINE THE EXTENT OF THE TIPS OR THEIR DEPTHS AT ANY PARTICULAR POINT," ACCORDING TO THE REPORT.

PREVENTIVE TREATMENT.—By combating water spraying to inhibit combustion in freshly tipped refuse and spreading and leveling to consolidate the older material, there is a prospect of disposal of refuse in a safe and not too obstructive manner. Research was begun to determine the effect on ground levels of discharges of sulfur dioxide from high chimneys and to save 3.5 million tons of coal and 3.8 million tons of coke. The project involved the development of new and more practicable methods of elimination than those in use. Experiments also have been carried out to reduce drizzle from water cooling towers about which there has been much complaint.

THE NUMBERS OF WORKERS REGISTERED UNDER THE ALKALI, ETC., WORKS REGULATIONS ACT, 1906, WAS 909 IN 1949, INVOLVING OPERATION OF 1,741 SEPARATE PROCESSES.

THAT WITH 1948, THIS SHOWS A REDUCTION OF 14 WORKS AND 23 PROCESSES. THIS REDUCTION RELATES MAINLY TO BYPRODUCTS OF THE COAL-CARBONIZATION INDUSTRY AND FOLLOWS THE TREND THAT HAS BEEN APPARENT FOR SEVERAL YEARS. DURING THE YEAR, ALKALI INSPECTORS PAID 3,752 VISITS, INCLUDING 378 TO, OR IN CONNECTION WITH, WORKS NOT REGISTERED UNDER THE ALKALI ACT, AND A FURTHER 200 TO, OR IN CONNECTION WITH, SPOIL BANKS. DURING THE INSPECTION, 2,198 QUANTITATIVE ANALYSES WERE MADE OF GASES ESCAPING TO THE ATMOSPHERE FROM THE PROCESSES IN OPERATION. A TOTAL OF 57 INFRACTIONS AGAINST THE PROVISIONS OF THE ACT WERE RECORDED. IN NO CASE WAS IT NECESSARY TO INSTITUTE LEGAL PROCEEDINGS.

THE PROBLEM OF POLLUTION OF OUR ATMOSPHERE BY SMOKE, DUST, AND GASEOUS WASTE PRODUCTS AND METHODS USED IN THEIR CONTROL ARE REVIEWED. THE SUBJECT IS PRESENTED IN TWO PARTS. PART ONE DEALS WITH CONTROL AND IS DISCUSSED IN THE FOLLOWING MANNER: DATA NECESSARY FOR METEOROLOGICAL STUDIES; LIMITATIONS OF RINGELMANN CHART; EMISSION STANDARDS WITH METHODS FOR DETERMINING THE QUANTITY OF DIFFERENT POLLUTIONS; CONTROL
measures with references to different equipment, machines, and recovery plants. The conclusion recommends, in part, reasonable standards and careful legislation for controls. Several references follow the article. (PHEA)


Discusses the following major problems in air-pollution control that still require solution: (1) Municipal; (2) economic; (3) administrative; (4) standards of measurement; (5) health relationships; (6) educational; (7) technical; (8) research.

It is emphasized that air-pollution-control programs cannot and will not endure without sustained, active, and forceful public support. Without such support the air-pollution-control administrator is doomed to defeat.


No simple answer can be given to the complex problem of city smog, but the safety engineer can help protect the public health by doing more to prevent industrial air contamination. He can contribute toward educational endeavors in specific factories for minimizing the chimney effluents, and he can see that samples are sampled, analyzed, and accurately interpreted. Of concern to him, also, are the different devices for controlling or abating discharges of pollutants.

Another function is his participation in public health educational endeavors of a community; the public must be correctly informed, by common sense consideration and the problems of pollutants involved, but without encouraging overanxiety or alarm. (PHEA)


Presents all the scientific and statistical data accumulated to date together with the administrative information on air pollution control in Los Angeles County. The procedures and methods used are not, however, described in detail, and only those results bearing on the mission of the district to reduce pollution are presented. Analytical methods, enforcement procedures, and supporting data have either been published in previous reports or will be reported in further technical papers.

Since April 1948 the pollution in the air of Los Angeles County has been reduced by approximately 35 percent. More than 6,000 sources that formerly emitted pollutants in excess of that permitted by law have been corrected.

Based on daily measurements and on the daily visibility cycles, as measured by the United States Weather Bureau, the improvement in visibility is at least 30 percent. Air concentrations of sulfur dioxide and sulfur trioxide are reduced by 50 percent.

Although eye irritation has not been eliminated, it is evident that the degree of irritation has been lessened and the frequency of attacks has been reduced.

The possible health hazard, an unknown part of the problem, is not discussed in this report.

The State law is now established as a wisely conceived enabling act. It provides for additional regulations should they be required, creates an Appeals Board to review decisions made by the district and grants the district jurisdiction over all sources within Los Angeles County, regardless of city boundaries. After more than 2 years of successful application, no need for revisions of the law appears to be necessary.


Discusses control of atmospheric contamination by industrial plants, with specific reference to the Los Angeles area. The method of approach, however, is applicable to any area where similar problems are encountered.

The significant factors in the use of the dust and fumes standards in effect in Los Angeles County are effluent-weight ratio, hourly mass rate of emission, and average mass rate of emission.

The application of these standards to open-hearth steel, electric steel, gray iron, and the nonferrous industry is discussed.

Special air-pollution-control methods are required in such industries as rendering plants; chemical fertilizer plants; chromate manufacturing; varnish, paint, and resin plants; detergents; vegetable-oil processing; oil refining; sulfur production; acid plants; paper coating; and food processing.


Observations of atmospheric pollution throughout Britain are considered in relation to the amounts of pollution emitted through the combustion of coal. The estimated weight of ash emitted into the air and the estimate, from deposit gages, of the ash deposited, are considered likely to agree fairly well at a figure of more than 10 tons/year. It is indicated that about 1.5 x 10^4 tons of smoke and about 1.1 x 10^4 tons of SO_2 are deposited in Britain, irrespective of quantities measured in deposit gages. The average life of a smoke particle before deposition on land is probably of the order of 1-2 days; that of a molecule of SO_2 is estimated to be less than 12 hours. Of the chlorides collected in deposit gages more than half, as a rule, come from the sea, and less than half from the utilization of coal; but the ratio will vary with the position of the deposit gage relative to the sea and to industries. (PHEA)


Recognized as one of the industry's big problems in the area of public relations, pollution of airs and streams from plant operations got much attention in the meeting. The board of management presented a problem that the industry must solve or have solved for it without due regard for attendant conditions. He told of the modeling of a State law to abate air pollution. In the report of the board telling of the creation and functioning of the air-pollution abatement committee, it was said that the committee has formulated a program of specific objectives, each under the guidance of a special subcommittee. These include (1) informing management on the trends of pollution-abatement activities, (2) liaison with other organizations interested in abatement studies, (3) public relations, (4) public health, (5) industrial toxicology, (6) legislation, (7) bibliography of pertinent literature, (8) exchange of technical information, and (9) preparation of a manual of abatement methods, which will deal with various types of chemical pollutants, safe tolerances, instruments for measuring, and equipment for control.

In the legislative field, the writing of reasonable and workable air-pollution-control measures has been handicapped by lack of fundamental knowledge of technical nature. Unfortunately, ignorance frequently generates unwarranted fear, with the result that drastic regulations may be imposed that are unnecessarily restrictive. In chemical manufacturing, as well
as in other branches of industry, this can discourage the continuance of existing operations or the establishment of new ones. Obviously, and especially in cases where restrictive legislation might be adversely affected in this manner.


Control of air pollution is affected by many factors: Wind erosion, unpaved roads, streets, and alleys; boiler-room housekeeping; and the general lack of dust-collecting facilities; heating, power, and transportation facilities that are not what they might be because of age, design, or lack of proper maintenance; building and plant owners, janitors and firemen, housewives and others who do not always operate their heating systems or incinerators properly; chemical fumes; exhaust gases and other byproducts; purchasing power; rental income, wages, salaries, taxes, return on the investment, and other economic factors.

Three of the factors—the equipment situation, the “human equation,” and a few aspects of public relations—are discussed.


Some practical application of the general principles and theories involved in the control of air contaminants. Nine cases of air-pollution problems are cited including those of rendering operations; phthalic anhydride, calcium carbide, and fertilizer production; and fly ash removal, which were investigated by the Michigan Department of Health. In each case the cause of the air contamination is discussed along the various methods applied to solve the problem to the satisfaction of plant and community.

The cases cited serve to illustrate the four points considered important in any method for collection of contaminants: (1) Selection of the suitable method or collector; (2) initial cost of the equipment and installation and whether the cost is justifiable; (3) maintenance of the equipment; and (4) whether disposal of the collected material is difficult or costly. (PHEA)


Atmospheric pollution is considerably increased by open and alley fires, which also offer hazards. Suitable incinerator equipment should be installed universally. To eliminate smoke and odor nuisances from incinerators, secondary combustion chambers should be provided with an auxiliary fuel source to maintain suitable settling chamber and other means. (PHEA)


Gives formula for assessing the nuisance caused by a certain quantity of fly ash leaving a chimney. It is found to be proportional to d, d, and d (d=diameter of particles), according to whether the number of dust particles, total surface, or weight is considered as significant. The principal properties of mechanical dust collectors (dry and wet systems) and electric precipitators are described. Special attention is given to the development of cyclone dust collectors and to results of investigations made in the Mechanical Engineering Laboratory at Delft for determining the optimum shape of a cyclone. (PHEA)


The control of air pollution has not progressed as rapidly as steam pollution, which came under Federal control in 1948. However, in time no one municipality, industry, or individual will be allowed to pollute the water or air that are common property.

One of the many examples of the interest in this subject at the State level is the recent announcement that the State of Pennsylvania has a new air pollution and industrial hygiene mobile laboratory, the first of its kind in this country.

Industries such as producers of nonmetallic minerals apparently are important factors of air pollution. The dust many of them create is not poisonous but in some instances it is detrimental to health and is a very obvious nuisance to those living near the plant. Voluntary control having lagged, all indications are that cities, State groups, and the Federal Government are taking steps against such pollution.


Reviews some of the corrective measures that have been supervised by the Atomic Energy Commission for treating harmful waste materials that result from the laboratory and production operations of the United States atomic-energy program. Problems that require further study are listed. A Monograph on Aerosols is to be published by the Commission. A table gives the best estimate known of maximum permissible atmospheric concentrations of certain ionizing radiation materials. (IHOD)

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The following activities are advocated: (1) Statutory control by administration of the powers available. (2) Special and routine observation of the smoke emission in the area under control. (3) Surveying the technical changes in plant construction for industrial purposes, and assisting changes which are effective. (4) Supporting and organizing technical courses of instruction in combustion and plant management for operatives, and, if need be, executives. (5) Undertaking or assisting investigation and research into the problems connected with atmospheric pollution and smoke abatement. (6) Public education by propaganda and popular lectures. (APB)


Reference is made to the fact that the paper under discussion brings together for unified thinking the research efforts and the practical man’s appreciation of certain findings that are the result of these efforts. Two approaches to the problem of reducing the creation of the censosphere rather than collecting them and trying to destroy them after they are created, as is now done, are suggested as follows: (1) Change conditions of firing or burning to reduce to a minimum the creation of cinders or (2) continue to create cinders and find better methods of disposition.


To eliminate the nuisance from incinerators, it is necessary that they be designed in accord with the following principles of combustion: Adequate combustion air; adequate combustion temperature; and thorough mixing of air and gases given off by the materials being burned. Additional steps should be adequate means of preventing the escape of fly ash, dirt, and smell.
Discusses some problems confronting the designers of incinerators.


Instances are described in which recovery of waste products would result in improving critical material shortages and decreasing dependence on foreign sources. For instance, one of the most critical mineral products, could be recovered in the impressive quantity of 700,000 tons annually from processing losses, which is approximately 50 percent of the yearly requirements of the United States. Rare metals, assuming an increasing importance in industry, are disappearing as waste products and recovery processes for germanium, gallium, rhenium, and selenium, now lost in flue dusts and smelter discharges, are yet to be developed.

Great Britain is said to be dissipating 1,000 tons of gallium and 2,000 tons of germanium into the air yearly in coal ash.

The chemistry department of the University of Tennessee has developed a process by which 100 to 200 pounds of germanium is recovered annually from molibdenum roaster fly dust.

Examples of remarkable progress in waste utilization and conservation cited are the recovery of sulfur from stack gases and incorporation of fly ash in portland cement making. Utilization of our mineral resources, however, is far below maximum effectiveness, with large tonnages of valuable commodities still being discharged to waste in air and water. The need of much additional fundamental and applied research is stressed.


This is an abstract of the Second Des Voeux Memorial Lecture delivered at the National Smoke Abatement Society Conference on September 26, 1951. A brief historical statement emphasizing the importance of industry to Britain, it refers to smoke as one of the examples of industrial waste. The 50 million Britons who live by industry are all against smoke and dirt and ricketts and polluter's deafness. There are those who see in smoke only the symbol of industry, whose attack on one is an attack on the whole basis of British life for the last 200 years.

The problem of smoke is said to fit squarely into the larger problem of the industrial future of Britain. It is a nuisance, but it is also more than a nuisance; it is a symbol of untapped resources available, ready at hand, in the waste of power, of materials, of industrial skill, and of scientific discovery. The life of a great nation depends on reaching down into these resources.


From the spontaneous resentment over the air-pollution nuisance has come a surplus of misdirected actions and hodge-podge of local municipal ordinances passed over the past 50 years. Smoke control in our cities today is essentially the product of this emotional reaction, with consequent failure in accomplishing real progress. Several measures are suggested for ways and means of overcoming smoke in cities.

A new approach is presented in which one proceeds from the correction of the smoke from the individual unit source of smoke to the general case as the facts are developed and weighed. Effective control in the simplest form, then, be initiated.


Difficulty was experienced through expansion of production facilities without proper planning of adequate cleaning installations for removing hydrofluoric acid, silicon tetrafluoride, boron trifluoride, and hydrofluorsilicic acid from three superphosphate plants in the vicinity of Rotterdam and an enamelfrit factory in the town itself.

Complaints of the people that their windows were dimmed, that vegetation was damaged, and that the smoke irritated their respiratory passages, combined with fluorosis of cattle, caused the municipality of Rotterdam to set up a "pollution committee" in the fall of 1948.

In cooperation with the industries concerned the following problems were investigated: Correct way of taking representative samples of stack gases; the phase in which the fluoride compounds presumably occurred; size of particles emanating from the stacks; methods of analysis suitable for continuous work; and devices for removal of the fluorides before the stack gases were emitted to the atmosphere. Methods of procedure and apparatus are discussed. (11 refs. cited)


This week, October 21-27, is Cleaner Air Week. Until this year known as National Smoke-Abatement Week, Cleaner Air Week has been designated by the U. S. Chamber of Commerce as the time "to focus attention upon the need for control of air pollution from all sources, including smoke, soot, fly ash, toxic fumes, and gases, and to serve as a starting point for year-round smoke abatement and air-pollution-control activity, by public officials, in the schools, in industry, by railroads, apartment houses and homes, and by civic organizations."

To promote Cleaner Air Week, its sponsor, the Air Pollution and Smoke Abatement Prevention Association of America, has distributed a number of slogans to the press and radio, including the following: "Save money—don't throw smoke away." "Remember Donora, Pa., and smogproof your future." "Careless firing pollutes the air—so be a good neighbor and fire with care." "Put air pollution on the run. Clean up the smog—bring out the sun." "Each person breathes 10,000 to 12,000 quarts of air a day—let's keep it clean."


A report on Manufacturing Chemists Association Conference on Air Pollution Abatement, held at New York, March 16-17. Important subjects discussed include:

1. Catalytic oxidation for disposal of dilute organic wastes not adapted to biological treatment, such as methanol, formaldhyde, ethylene glycol, etc. Waste is vaporized, mixed with preheated air, and passed over copper chromite catalyst. As compared with burning with natural gas, catalytic oxidation is cheaper for wastes with low organic concentrations.

2. Problem of air-pollution dust contained in large volumes of stack gases from calcium carbide furnaces. Dust comprises particles of lime, coke, and magnesium oxide, which are removed by dry separation in a rotoclonc. Total suspended solids are 90 percent removed.

3. Causes of Los Angeles smog, believed principally due to (a) unburned or partly burned organic vapors emitted by autos, trucks, incinerators, and vents, which react with oxidizing materials in atmosphere to produce eye-irritating and other compounds, rather than to (b) industrial stack discharges.

4. Petroleum-refinery-stack emissions, which are controlled by securing efficient primary combustion, further burning of emissions, control of losses, use of closed systems, and controlled burning of gas leaks.
CONTROL OF AIR POLLUTION

2115. **Snog or Steel?** Vol. 29, 1951, p. 1290.

Bethlehem Pacific Coast Steel Corp. in Los Angeles has been operating its open hearths without smog controls but the company's been denied a variance which would permit it to go on emitting wastes in greater quantities than permitted under the stringent Los Angeles County regulations. Result: Any day now a court down that way may be asked to choose which is more important, steel for national defense or a few tons of smoke per day—which, when added to hundreds of thousands of tons from other sources, accounts up the famed Los Angeles smog. Meanwhile Los Angeles County foundries are installing smog-control equipment at an accelerated rate. Additional orders are being placed for electrostatic precipitators, equipment based on the baghouse principle; in at least one case, permission has been granted for installation of sonic control devices, using sound waves and wet scrub to eliminate emission.


Pollution of air and streams has become an extremely serious problem in the United States—and the enormity expansion brought about by defense is not easing the situation.

Water supplies must be conserved and the atmosphere cleaned up if our high standards of living are to be maintained.

Reference is made to the series of articles, following the editorial, that puts the problem, its causes, and some of its solutions on a sound and scientific basis.


Air pollution, although harder to assess dollarwise than water pollution, still causes great loss and is important psychologically.

Many pollution-control symposiums have been held during the past 2 years, and are still being held. Unlike the average pollution control specialist, which tends to obscure the fact that pollution control is everybody's business. The reason for adding another symposium to the long list is to bring the problem home to those who are not specialists.

Chemical Engineering offers a group of 12 articles in three parts: A general introduction, the water-pollution problem, and the air-pollution problem. In the air-pollution section one article opens the subject by showing what the problem is, and the remaining articles answer the question of how pollution can be controlled.

2118. **Chemistry. Dust and Odors of Industry.** Vol. 24, 1951, p. 43.

Chemical manufacturers should bend over backward in their efforts not to permit the discharge of obnoxious or deleterious amounts into the atmosphere. However, the public must accept the fact that, since they live in an industrial community, they cannot expect an odorless, dustfree atmosphere.

It is unfortunate that there are few sound definitions of what is dangerous or harmful amounts into the atmosphere. However, the public must accept the fact that, since they live in an industrial community, they cannot expect an odorless, dustfree atmosphere.

The best assurance the public can receive is, of course, that equipment be installed to remove substantially all odorous and corrosive waste-gas discharges. To do this requires a careful and thorough study of all the analytical problems that are involved.

Methods for controlling air pollution include disposal through stacks, meteorological control, use of filtration, sedimentation, scrubbing, adsorption, and incineration equipment. The selection of the proper equipment is based on experience combined with the application of chemical engineering principles of mass transfer, fluid flow, and material handling.


It is said that the public often fails to appreciate that, when coal is burned in such a way as to foul the air, it is being used uneconomically. It had been estimated that so wastefully do we use our resources that we waste as much as 80 million tons of coal a year. The director of fuel research for the Department of Scientific and Industrial Research estimated that, of the 190 million tons of coal burned in 1948, 7,250,000 tons went straight into the air in the form of 2 million tons of tarry smoke, over 500 million tons of grit, and 4,750,000 tons of sulfur.

Those concerned with the problem of dirty air added a number of charges to the indictment. They believed that smoke and smoke were bad for health; ruined buildings; and made for drabness and depression in the industrial areas. It was not possible to calculate the total cost, but it seemed improbable that it was less than £200 million a year. It seemed that there was no direct connection between polluted air and the development of tuberculosis, but it seemed fairly clear that a dirty atmosphere exacerbated the disease and might, in the long run, hasten death. There seemed, on the other hand, a good deal of evidence for saying that there was direct connection between smoke pollution and cancer of the lung.

The second charge was on grounds of damage to agriculture and natural life. In East Lancashire the pollution of the atmosphere was such that land in the Rossendale Valley needed an extra 5 cwt. of lime per acre per year to put it into good condition. Around the Burnley district the figure was nearer one-half ton. Other effects of pollution were difficult to assess. All one knew was, in an example, that the laundry bills in Manchester were much higher than in Harrogate. Chain stores found that their bills for decoration in industrial areas were twice those in the country. The joint stock banks spent far more on cleaning in the smoke-ridden cities than in rural areas. The work of the housewife was made infinitely more difficult and discouraging.


The vital and strategic importance of solid fuels to the health, economic welfare, and security of the Nation is unquestioned. Solid fuels are a basic element in our economic strength, industrial leadership, and the defense production program. Indispensable in the maintenance of a normal economy, solid fuels are one of the main keys to success in a defense program.

The organization, functions, and powers of the Defense Solid Fuels Administration are discussed. The functions and powers with respect to solid fuels include the power to assign priority ratings to different uses of solid fuels; to allocate solid fuels to essential uses; to curb excessive inventories; to make recommendations with respect to applications for loans and certificates of necessity for the expansion of productive
capacity and supply; and jointly with respect to solid fuels. These include the power to assign priority ratings to mining machinery and equipment and to make allocations thereof to essential uses. The Defense Solid Fuels Administration also acts as claimant for the soil fuels industries.


Cranford discusses the reduction of atmospheric pollution arising from the use of coal. When coke is burned, 90 percent of its contained sulfur is released, mostly as dioxide and partly as trioxide. About 2.3 million tons of sulfur are thus released into the air over Great Britain each year, and all of it is finally washed down by rain as very dilute sulfuric acid. Even in the industrial area of a large town, the concentration of sulfur dioxide in the air rarely exceeds 55 parts per hundred million.

It is impracticable to remove sulfur from chimney gases except in the largest coal-burning installations. The only positive action that has been taken is the stipulation by Parliament that most of the sulfur should be removed from the chimney gases at the London electricity-generating stations at Battersea, Bankside, and Bankside—but for the country as a whole generating stations are responsible for only 17 percent of the sulfur output, and in London 28 percent. Moreover, their gases are discharged to the upper air to a far greater extent than the gases from domestic chimneys.

The sulfur-removal plants at Battersea and at Fulham—the only full-scale plants built in any country for removing sulfur compounds from flue gases—are briefly described. At Battersea the latest estimate of the cost of removing sulfur is about seven shillings per ton of coal burned if a new plant were being built, and the capital cost would be at least £1,000,000 for a station burning 1 million tons a year. The cost of the Fulham process would now be 10 shillings for every ton of coal burned, it is estimated, and the capital cost would be greater than for the Battersea process.

No economic process has yet been developed for the recovery of the sulfur present in flue gases. (See also item 2147.) (AIOM)


The first act dealing with spoil banks (as a nuisance) was passed in 1867 and during that year the Alkali Department of the Ministry of Health developed the methods of treating the heaps with a fine spray of water. This method, though effective, is temporary and it was recently proposed to stow underground 300,000 tons of material at Donithorpe colliery (Leicestershire). This method has been used extensively in Germany and a description is given of the machinery used in pneumatic stowing. (APB)


The problem of linseed-oil-fume disposal by the National Lead Co. is discussed. Study of various methods revealed that water was the cheapest and most practical to use, as it could be run into the sewer and was the best solvent for the acrolein constituent of the fume. Tests with an experimental scrubber indicated that the fume could be eliminated satisfactorily and a large scrubber, designed to handle 2,000 c.f.m. of fume-laden air was set up in the plant.

Even though as much as 95 percent of the mass of the oil fume is removed by scrubbing the residual fume is still dense enough to be easily seen and may indicate only a 50 percent reduction in density.

Complaining neighbors were not satisfied until they could not see the fumes, even though the odor was removed.

Virtually complete elimination was attained so that the faint residual fume going out the top of the stack could be detected with difficulty against a dark background. Also, the odor of acrolein and other aldehydes was definitely gone. The measures by which success was attained are described in detail.


Further comments on smoke abatement in general, application for the chemical and other industries, and room ventilation.


The effluent from wire-enameling ovens contains several ingredients which are irritating even in small concentrations, creating an atmospheric pollution problem. The results of tests described in detail indicate that catalytic combustion of the effluents can greatly reduce the atmospheric contamination and escape of combustible materials. The general method of catalytic combustion should have possibilities in control of atmospheric pollution wherever the contaminants are combustible or readily oxidized to less irritant compounds. Each installation should have chemical and physical tests made on the oven and stack effluents in order to determine the optimum operating conditions and verify the reduction of the contaminants.

A minimum of instrumentation should be necessary for indicating the continued activity of the catalyst. The entire project is still in the experimental stage, and additional tests are being conducted. (AIOM)


Extensive investigations and testing of overfire jet arrangements on stoker-fired lake cargo vessels were undertaken. The research program developed specific jet arrangements which demonstrated their effectiveness in abating smoke, and basic requirements of a suitable jet installation, operating procedures affecting smoke performance and jet arrangements that have proved effective are reviewed. (APB)


In any air-pollution-control program it is essential that adequate and reliable means be adopted for assessing the results. More observations, even by trained observers, have little value.

Where studies are to be made of any particular or related group of contaminants, they must be correlated with the general air-pollution level and the affecting meteorological data, if logical conclusions are to be drawn.

The answer seems to be to make use of as much automatic equipment as possible for collecting samples and recording related factors. Available personnel may then be used for compiling and analyzing the data collected, or for any special studies required.

The best methods for measuring air pollution levels are presented and discussed. (7 refs. cited)

The importance of climate in the control of air pollution is stressed, the different conditions prevailing at different places such as Los Angeles, Pittsburgh, and Kansas City being pointed out. What is needed is a more detailed approach to the specific conditions prevailing at the polluted area.

2129. INDUSTRIAL HEALTH MONTHLY. County Health Officers in West Virginia Help Industrial Hygienists Evaluate Local Air-Pollution Problems. Vol. 11, 1951, p. 188.

The value of cooperation of local health units in aiding West Virginia's Industrial Hygiene Bureau to evaluate the air-pollution problems in their particular vicinities is emphasized.

When a task force is sent to an area to study a specific problem, meteorological conditions or other factors may be so unusual that it is impossible, within a reasonable time, to obtain technical data on the problem.

Inasmuch as the local health departments are closely concerned with studies, they cooperate willingly with the industrial hygienists who must determine the magnitude of air-pollution problems and work out means of control.

Examples of such cooperation are investigation of fly ash from a power plant; of dust from a plant engaged in crushing and sizng blast furnace slag; of smoke and gases from burning "gob" piles; and of dirt settling in an area from limestone and cement plant.


A rather unique approach to the extent of an air-pollution problem and what can be done to solve it is being tried in the Charleston, W. Va., metropolitan area. The plan includes the cooperation of three groups, the health department, industry, and a citizens' committee, in a survey involving engineering and chemical studies. Procedure is outlined briefly.


The measures taken by the Aluminum Co. of America to comply with the Rules and Regulations of the Air-Pollution-Control District of Los Angeles County, which became effective January 1, 1948, are presented briefly.

The extensive and costly test program, only briefly outlined here, has been justified because the new operating techniques developed not only have eliminated the need of making substantial investments in fume-control equipment but also have noticeably improved general operating conditions and production. The test program is being continued at several points of Aluminum's, at Aluminum Research Laboratories. New and improved production processes are being developed and new ideas of fume and smoke collection are being studied.

The test program clearly demonstrates that each problem of fume control must be solved individually. Operating conditions, type of fume, volume, and temperature of gases are important factors governing the type of equipment selected. Likewise, the end results desired or required affect the selection; that is, what degree of fume control is necessary for the particular problem. In some cases the material may have a salvage value if it is collected under specific conditions. Therefore, it cannot be stated that any one type of 238157—54—17

device has its own merits and advantages which will become deciding factors in specific applications.


The broad research objective of the Los Angeles studies has been to define the air-pollution problem so that a control program will be more specifically, the work has entailed identification of pollutants, appraisal of their effects at the concentration levels found in the air, instrument development, and collection of data for determining the effectiveness of control measures. The Air-Pollution-Control district operates permits adoption of all necessary regulations to reduce the pollution in the affected area. It has been necessary, therefore, as the various contaminants were identified, to establish the relationship of each to the community problems. The impurities in the air over the Los Angeles Basin produce four known effects, as evidenced by the reduction of the visibility on as many as 200 days of the year, extensive damage to leafy vegetable crops, eye irritation on 70 or more days of the year, and the usual nuisances from odor or excess deposits in local areas.

The unfortunate meteorological conditions, together with the terrain features that concentrate the pollution, also create a regular pattern for the air flow. Sampling periods are dictated by the time of retention of the contaminants in a given area. At most of the sampling stations, collection is limited to about 2 hours. The application of instruments and methods is based upon the broad classification of the pollutants into two types, aerosols and gases. Procedures used for studies of the solid or liquid aerosols may be unsuited for use on gases or vapors.

It is concluded that air-pollution control is now concerned with a new field of combustion, which might be called "cold" combustion in the atmosphere. These chemical reactions with certain organic contaminants produce a smoke-like haze and irritating vapors. The reactive products entering the atmosphere must ultimately be controlled at the source in areas where their harmful effects can be demonstrated. A future threat to plant life around all heavily populated districts is foreseeable from these findings.


In the normal type of funnel the boiler uptakes are surrounded by a streamlined casing. When the ship is in service the wind impinging on this casing causes a region of turbulent flow to be formed, and the exhaust fumes are ejected into this region, and may be carried down on to the deck. In the Laseroux funnel all the uptakes are combined into one, which is carried up level with the top of the funnel. Alongside this uptake is a duct through which foul air is exhausted, while the wind impinging on the casing passes through openings and is deflected upward to create an upward flow of air in the neighborhood of the boiler uptake and foul-air exhaust duct. As a result, all fumes are carried clear of the turbulent region surrounding the funnel, and there is no danger that they will be carried down to cause a smoke nuisance on the deck. Photographs are reproduced of wind-tunnel tests in which the speed of ejection of the exhaust fumes was zero, while the relative speed of the wind was 30 ft. per sec. Under these adverse conditions it was found that, whereas with the normal type of funnel, the fumes were swept over the after edge of the funnel directly into the region of turbulent flow, with the Laseroux funnel the fumes were carried upward and were some
10 feet clear of the after edge of the funnel. In addition to abating the smoke nuisance, this type of funnel, by preserving the velocity of the exhaust smoke, causes smuts and solid particles that may be present to be carried well clear of the ship. Successful installations have been made in a number of vessels. (APB)


Reports from Detroit, Pittsburgh, and Cincinnati indicate considerable success in controlling atmospheric pollution. In Detroit, approximately $14,000,000 has been committed for control equipment by industry as a result of investigations and corrective measures initiated by the Bureau of Smoke Prevention and Abatement. Illegal emission of smoke is relatively rare, evidenced by the fact that smoking stacks are seen infrequently in the city. However, many types of emission are at the nuisance level, a state for which there are no acceptable remedies. Pittsburgh reports a decrease of 51.6 percent in total hours of smoke per year from 1945 to 1950. The average monthly dustfall decreased from 55 tons per sq. mi. in 1948 to 40 in 1950. In Cincinnati the total annual dustfall was reduced last year from 30.4 to 29.0 tons per sq. mi. Tables are given showing hours of smoke in Pittsburgh each month and dustfall measurements in Cincinnati. (HOM)


That research and equipment development follow closely the industrial demand for more efficient and cheaper methods of controlling air pollution was revealed in the technical papers read before the 12th International Congress of Pure and Applied Chemistry. Operating data presented by investigators on edge filtration characteristics of nine filter mediums, as well as information on sampling equipment, are summarized.


A nine-point proposal spelling out how the American Society of Mechanical Engineers can contribute most effectively to the solution of national air-pollution problems, was adopted by the Steering Committee of the A. S. M. E. Air Pollution Controls Committee at a meeting in New York, late in 1850.

The A. S. M. E. Air Pollution Controls Committee was created in 1949 as the result of the report, Example Sections for the Air Regulation Ordinances, prepared by the Model Smoke-Law Committee of the A. S. M. E. Fuels Division. Wide distribution of this report revealed the need for documents that approach air-pollution control from a broader base than that of smoke alone.

Some 30 organizations known to be interested in air pollution were invited to send representatives to a meeting in New York, N. Y., in November 1949 to organize a program for the A. S. M. E. participation in the problem of air-pollution control.

The Scope Committee’s first recommendation concerned preparation and publication of a historical summary of the problem of air pollution, which would include abstracts of important documents, reports, and technical papers useful to workers in air-pollution control.

Publication of a pamphlet of loose-leaf sheets that would make available current information on air-pollution projects and trends of control by manufacturers and public officers, was the second recommendation. Since many organizations are at work on different phases of the problem, the Steering Committee felt that such a service was needed but that it would be necessary to avoid duplication of effort, and that the society might well act as a clearing house for such information.

The third project was promotion of a series of authoritative papers defining and redefining substantial economic and public-health requirements for the abatement of nuisances and troublesome emissions. These papers the Committee felt should differentiate between the requirements of dust-free atmospheres in various conditions, for example, those in hospitals, paper mills, food-processing plants, cement mills, and others.

The A. S. M. E., through its Air Pollution Controls Committee, could also encourage preparation of economic analyses to show the dollar efficiencies of degrees of pollution abatement and the effect on communities or neighboring industries. In considering this recommendation the Committee agreed that the economic aspects of air-pollution control could not be ignored.

Proposal 6 suggested that the society foster studies of fuel use in all categories by areas and the relationships of emission to types of equipment and the use of alike types of fuel in the same areas. Research data defining upper limits of emission, as influenced by topography, meteorology, and stack-discharge position, would be helpful. The committee agreed there was insufficient reliable information on the influence of terrain on air pollution and that the society should cooperate with the American Meteorological Society in this aspect of the problem.

The final proposal was a project for development and codifying measurements of contaminations as to a method of accuracy, for approximate, and visual checks as to density. Subcommittees are currently being organized to undertake the projects recommended by the Scope Subcommittee.


Coal smoke, the suspended material from the combustion or destructive distillation of coal, varies in its content of tars and "free" carbon according to the combustion temperature. Brown smoke is produced by the distillation of coal in a fire, while black smoke is caused by higher temperatures or where the flames have been chilled. Industrial chimneys produce mainly black smoke, while the British domestic grate produces a mixture of the two. Domestic smoke is high in tar and "free" carbon and low in ash; factory smoke is low in tar, lower than the domestic in "free" carbon, and high in ash. Smoke particles are 1A in size or less; it has been shown that half the total number of smoke particles are less than 0.075A in diameter. These small particles are very mobile but tend to agglomerate.

Smoke in chimney stacks can be measured gravimetrically or optically; smoke leaving the chimney is commonly measured by means of the Ringelmann chart or similarly; smoke in the atmosphere is best measured optically by a stain produced on filter paper. Estimates in Britain show that, of an annual coal consumption of 190 million tons in 1948, 37 million tons was consumed in domestic grates to produce about 900,000 tons of smoke out of a total of 2 million; industry used 63 million tons to produce 700,000 tons of smoke.

The factors affecting the dispersion of smoke are stack height and location, discharge temperature, wind velocity, and other meteorological conditions. Atmospheric turbulence has been shown to be particularly important. Smoke is caused by incomplete combustion, and this can be combated by insuring an adequate supply of secondary air. The author describes the "smoke-eliminator" doors designed by the Fuel Research Station for use on hand-fired boilers; overfire air jets have also been used for this purpose. Manu-
facturing processes requiring reducing atmospheres in furnaces pose special problems, and gas-firing has been much used. A considerable reduction of smoke would be achieved if the domestic open grate were replaced by more efficient appliances and there were domestic combustion of smokeless fuels. (AIHOM)


Text of papers read at the conference on the following subjects: Smokeless operation of small steam-raising plant; policies for the prevention of industrial air pollution; smoke prevention in the home. (FA)


Technical, economic, public relations, and legal aspects of the problem are discussed. It is pointed out that air and steam-pollution problems due to increase in population and in industries have expanded to the point where the public has become aroused (and sometimes unnecessarily alarmed); that lawsuits and Government regulations are increasing, but that technology is lacking. Economic aspects such as increased cost of water treatment, correlation between cleaning bilts and sickness and air pollution are being recognized.

Industries must recognize the value of control measures for air and water pollution (1) to avoid lawsuits,(2) to retain the good will of their communities, (3) to comply with laws, and (4) to do their part in avoiding a stream pollution situation that might eventually become intolerable for all industries. In public relations, industry should realize that silence is not golden. Certain ephemeral laws are discussed, as well as current and pending legislation, and there is a comment on the problem of the vagueness in laws on the subject. (PHEA)


The smog stopper briefly described is the first of its kind to be approved by the Los Angeles County air-pollution authorities. The stack gas goes through water-spray conditioning chambers attached at the cupola tops. The cooled gases are then pulled into a giant baghouse, where the solid particles are trapped. Nonflammable bags are mounted for continuous operation, and any one of five sections can be closed down for shaking or bag replacement. All gases and over 95 percent of the solid particles given off by two cupolas are removed. (PHEA)


The coal industry proposes to organize a National wide fuel and equipment consulting service for small steam plant. Such a service should embrace all of the factors that require expert attention to ensure complete consumer satisfaction.

Results are given of an analysis of equipment surveys in 25 cities made by the Coal Producers Committee for Smoke Abatement.

One problem common to all coal-producing districts is the competition of laborious fuels. Ways of meeting this competition are discussed. It is up to the engineering profession to prevent the squandering of irreducible oil and gas reserves for uses in which solid fuel can be applied by the present generation without sacrifice. (PHEA)


Text of a report submitted to the Commissaire supérieur de l'hygiène on the modification of the French regulations for the construction of flues, including flues for gas. In French, with English summary. (APB)


First of a series of articles, based on investigations of smog problems peculiar to southern California, to be published by Petroleum World. This indicates the importance attributed to the ramifications and aspects of the smog problem. Progress and expansion in the arts and sciences have largely aggravated the problems of dust and fumes—smog—while ever increasing concentrations of population have accelerated and intensified the demands for remedies.

Various types of equipment used in the suppression of dust and fumes are discussed. (26 refs. cited) (AIHOM)


The air-pollution problem is reviewed. Various types of contaminating emissions and the relationship which meteorological and topographical conditions bear to the ground-level concentrations in a given locality are discussed. The specific problems confronting California are emphasized along with suggested means of control. (26 refs. cited) (AIHOM)


To solve effectively all problems concerned with the discharge of waste gases into the atmosphere the future should be considered and understood by management and engineering groups: (1) Legal and social; (2) analytical; (3) economic; and (4) engineering.

The chemical industry contributes to air pollution by discharging into the atmosphere odors, acid gases and fumes, and alkaline fumes and dusts. The best way to attack the problem of air pollution is to prevent the discharge of pollutants into the atmosphere.

Various methods of control are discussed. The conclusion is that the best way to control air pollution is to anticipate it by proper process engineering, by location of the plant in a suitable nonresidential area, and by the use of good housekeeping procedures in the operation of the plant. (PHEA)

2146. Smokeless Air. Summer Hundred Years of Smoke Prevention. 1931, pp. 140-145.

A review with illustrations of outstanding events in history of smoke prevention in United Kingdom: Select Committee of 1845, fogs of 1873 and 1880, exhibition of 1881, foundation of N. S. A. Institution in 1882 which was replaced by Coal Smoke Abatement Society in 1899, and finally the formation of the present National Smoke Abatement Society in 1929. (APB)


Sparkes discusses the elimination of smoke. To this end it is necessary to burn the coal in such a way that smoke is not formed in the furnace. The main cause of smoke is discharge of hydrocarbons from the fuel bed, and to burn these a separate supply of "secondary" air over the fire is needed. The most usual cause of smoke emission is lack of this secondary air—often because boilers are constructed without provision for supplying it.

Smoke eliminators devised at the Fuel Research Station are described. In these it is arranged that the air is admitted so as to ensure intimate mixing with the combustible gases. With heavy smoke emission there may be a loss of thermal efficiency to the extent of about 12 percent, and, on the average, boiler plant elimination of smoke can be expected to achieve a saving of 5 percent. (See also item 2121.) (AIHOM)
A BIBLIOGRAPHY


Because of the need to reduce atmospheric pollution in the United States, recently designed industrial incinerators have had a secondary combustion zone to allow enough space, time, and air for the effluent gases to burn completely before discharge to the atmosphere. In some cases an auxiliary supply of heat is needed in the secondary zone to get sufficiently high effluent temperature for complete combustion; this is usually a gas flame imposed across the direction of waste stream flow. An example is given of an incinerator using a second stage combustion zone now in use at the Wilson Packing Co., Los Angeles. (PHEA)


The use of activated carbon in preventing air contamination by odorous and toxic compounds is discussed. The adsorption limits of activated carbon are defined in terms of basic physical phenomena. Reasons why activated carbon is the preferred adsorbent for removal of gaseous pollutants are also presented. Two tables are included: (1) The retentivity of carbon for 10 gaseous pollutants commonly found in industry and (2) specifications for gas adsorption columns. Industrial installations employing banks of 25 c. f. m. carbon columns and 700 c. f. m. carbon cells are illustrated and their operation described. Formulas for determining service life of carbon elements and concentration of pollutant present in atmosphere are given. (PHEA)


(1) Incineration is one of several processes suitable for disposal of organic refuse. Incineration should be considered as an intermediate step in the disposal process, as there remains the ash residue to be buried and large volumes of gases to be dispersed into the atmosphere. (2) Incineration is not economically competitive for disposing of municipal refuse when short-haul, semi-isolated land areas are available for extended land operations. Hence, incineration is not usually found application in large cities or in small cities that are part of a large, highly urbanized metropolitan area. (3) Designing municipal incinerators for continuous, 24-hour operation will insure minimum construction cost and maximum operating economy. Adequate refuse storage is essential for proper around-theclock performance. (4) Stack discharges from municipal incinerators comprise gaseous and particulate matter. A determination of the precise effects of these discharges requires further field studies. (5) Contract documents for constructing municipal incinerators may include general plant drawings, but otherwise they should be functional to permit competitive bidding. Engineering evaluations can afford protection against poorly conceived or badly engineered designs, and assist the development of improved processes and equipment. (6) Whenever possible, incinerator locations should be governed by the following criteria: (a) Centrally located for economic haul by collection vehicles. (b) Adjacent to industrial area for convenient outlet of salvageable products and waste heat. (c) Minimum nuisance from vehicles, noise, ash, odor, etc. (d) Land at reasonable cost. (e) Two-level topography for minimum construction cost. (f) Ash disposal within economic haul. (g) Satisfactory meteorological environment. (h) Compliance with regulations, for example, zoning laws, air- and water-pollution-control laws, etc. A municipal incinerator is an expensive facility that requires constant technical supervision to maintain optimum performance. Improper supervision will result in unnecessary and excessive costs for operation and repair. (PHEA)


The odor and dust-control provisions of the District of Columbia's refuse transfer station where garbage and other refuse are transferred from municipal collection trucks to tractor trailers, railroad cars, and pig feeders' trucks are described. Spin-glass filters and activated carbon are used for dust and odor control during the times of day and the seasons when necessary; at other times the air is exhausted through a 100-foot-high chimney. (PHEA)


No legal standards for alleviation of air pollution.英格兰 examples are Garfield smelter, the Sullivan plant in British Columbia. Containment of dust and vapor is progressing. Higher smokestacks solve some problems, but not for the new sulfur problem at Trail smelter in British Columbia. Some change in plant operation may become necessary. Widening section ahead of stack helps. Cyclone separators present simple device. To reduce particles to 0.05 small ones cost 4 to 8 cents per cubic foot of gas per minute, larger sizes 50 cents. Bag filters reduce to 2 μ and cost 50 cents to 1.50 per c. f. m. Cotterell system catches 90 to 99 percent of particles of all sizes. Cost $1.50 per c. f. m. and 10 to 50 cents for maintenance. New ultrasonic flocculator high-frequency siren agglomerates down to 2 grains per c. f. m. For sulfuric acid fog, cost is $1 per c. f. m. Wet scrubbing will reduce to 2 μ. Cost 30 cents to $1 per c. f. m. and require 3 to 10 gallons of water to 1,000 c. f. m. Absorbers only known remedy for vapors. Cost predictions impossible, varies from 50 cents to $10 per c. f. m.

Air pollution can be controlled if public will stand cost. Industry sometimes cannot stand cost. Will add cost to products and enforcement.

1953


Discusses what should be done about dust from playgrounds, parking lots, coal yards, and similar sources. When is being done to control such dust in a number of cities is stated briefly.


The appointment of Frederick S. Mallette as executive secretary of the Committee on Air Pollution Controls of the A. S. M. E. marks another step forward in the society's continued alertness to problems of interest to its members. A brief statement is made of the air-pollution work of the society in the past.

The future objectives of the committee are outlined as being in part, but not exclusively, to initiate and coordinate research concerning health, comfort, nuisance, engineering, and economic aspects of the problem, to collaborate in formulating and publishing standards of appropriate nature, to encourage and assist in preparing, presenting, and publishing papers on the many phases of atmospheric pollution. The seven-point program to implement the objectives consists of:

(a) Sponsoring preparation and publication of a historical summary of the air-pollution problem.
(b) Providing a clearing house for information on control projects and trends among manufacturers and public agencies.
(c) Defining accepted economic and public health requirements for abating nuisances or troublesome emissions.
(d) Encouraging preparation of economic analyses to measure efficiencies of various degrees of pollution abatement and the effect on the community or adjacent industry.

(e) Fostering the study of fuel use of all types, the actual emissions of different equipment, and the efficient use of all fuels in the best equipment.

(f) Stimulating research for defining upper limits of emission as influenced by meteorology and stack-discharge location.

(g) Developing and codifying specific approximate and visual measurements of contamination and density of emission.


For the first time in the United States, Philadelphia has isolated the chemical components of odors produced by specific industries and developed methods for measuring them in such a way that they now become subject to municipal regulation. This will pave the way for economic rejuvenation of certain areas that have become blighted by unfavorable atmospheric conditions.

The success of this far-reaching experiment was revealed by Franklin Institute at a conference sponsored by the City Planning Commission and the Redevelopment Authority.

The devices for collecting and determining the chemical components of odors developed by Franklin Institute now open up new possibilities for municipal control in this field, so as to reduce and eliminate the blighting influence on property values over large areas.

In accepting, the chairman of the Redevelopment Authority and the Planning Commission said in a joint statement that consideration should now be given to the possibility of strengthening the 1948 Philadelphia air-pollution ordinance, which does not cover contamination by odor but is concerned with density of smoke, of smoke and pollution with noxious, but not obnoxious, fumes.

Describes equipment and methods used in determining odors.


Plans for a new long-term research project, to learn exactly where Chicago’s dirt comes from, are outlined.

The new project will include a statistical survey; a microscopic study of dustfall to determine the source; and an educational program.


Weirton and many other steel companies are working on various phases of the smoke-control program at the present time, with some firms concentrating research on blast furnaces, others on bessemer, some on open hearths, and others on methods to eliminate smoke from boiler and power plants.

The Industrial Hygiene Foundation has been engaged by the American Iron and Steel Institute to make a study of air pollution. This study has included research on the chemistry of combustion, development of low-cost instruments for measuring air-pollution intensity at ground level, and a project on the behavior of dust particles in smokestack gases.


The shortage of steel scrap, which may reach alarming proportions, has caused a number of patriots to request that additional scrap be obtained by scrapping up the demolition of automobiles in junk yards.

These “jalopies” could be prepared, according to the suggestions made, by burning away all combustible material, then compressing the bodies by dropping a 2-ton piece of armorplate on them, and then hauling away the wrecks to the nearest steel mill, eight to a load.

These suggestions caused consternation in many places, since burning auto bodies would violate the antismoke ordinances in many communities. An attempt was made in various quarters to get city councilmen to relax the ordinance during the emergency, but this suggestion met heavy opposition from air-pollution-control officials, who did not wish to see their efforts even temporarily nullified after they had fought so hard to get the ordinances passed.

Some local restrictions against the usual method of demolishing automobiles by burning the combustible material are cited. Some suggestions for handling the problem are included.


The rapid rise of industrial Los Angeles to international prominence has been accompanied by a record influx of population, together with greatly increased pollution and fabrication of steel and nonferrous and light metals; industrial mineral processing; and high consumption of fuel oil, gasoline, and chemicals. These have resulted in the release of hundreds of tons of metallurgical and mineral dusts, fumes, and gases into the atmosphere daily. Meteorologic and topographic peculiarities of the area, which result in poor drainage of the polluted air away from the Los Angeles Basin, serve periodically to greatly increase the intensity and frequency of industrial smog visitations. This condition of intense industrialization, population influx, climate, and topography has made mandatory control of air pollution necessary.

Among the many factors in the control of metallurgical and mineral dusts and fumes in the Los Angeles area, two are perhaps most apparent as the campaign matures: (1) The necessity for a high recovery of micron-size particles and the difficulties involved in this are becoming better appreciated; and (2) the fact that the electrical precipitator and the baghouse are the most versatile and positive devices demonstrated industrially to date for accomplishing the necessary end. The precipitators, large and small, operated wet or dry, are the answer to some of the most difficult problems in ferrous and nonferrous metal and mineral-mineral processing. Units as small as 10,000 c. f. m. are in satisfactory operation, and smaller and less expensive ones are expected to be available in the near future.

Baghouses, particularly those designed and equipped for operation at high temperature (250°-500° F.), are producing excellent results in both ferrous and nonferrous work at costs that most industries can afford. These and other types of equipment, including the dynamic wet scrubber and packed tower, found suitable for specific applications alone or for use in combination with others, make adequate control of metallurgical and industrial mineral dusts and fumes an eventual certainty.

Rules and regulations of the Air-Pollution Control District are appended. (86 refs. cited) (Adapted from authors’ summary)


Discusses smoke control in Pittsburgh. Describes methods used in educating the public in the subject and getting the various industries concerned to cooperate in the enforcement of air pollution ordinances.

The theory of dust chambers and centrifugal cleaners is discussed, and nomographs are given for calculating the volume of flue gases, dimensions of dust chambers, weight of dust, radius of dust dispersion, and size and speed of centrifugal cleaners. (APB)


There are two ways to end the nuisance of smoke. One is to give up industry; the other is to get rid of the smoke.

An emphatic objection is offered to the maligning of the industrial revolution. Certain blots on industry are cited and should cause shame, but industry itself is nothing to be ashamed of. A brief reference is made to the importance of industry in the past and to the great men who developed it in England. What the industries of Britain will have to do in the future is to make the most of its resources. The new industrial revival depends on using the wealth of energy that is wasted day in and day out. It is the 20 cwt. of energy that is used in every ton of coal, and the 17 of these ideal cwt. that is thrown away; it is the smoke up the chimney and the soot on the boiler, the steam that goes to waste in the cooling towers and the smell around the gas works, and a million inefficient appliances in every factory and home.

Smoke is a nuisance; and every discovery man makes sets for him at the same time a nuisance problem. In 20 years the nuisances will be the atomic wastes. If an end is made of the present wastes at once, we shall be just in time to become the National Society for the Abatement of Atomic Wastes.


Reference is made to the difference of opinion between the scientific smog experts and municipal authorities that appeared at the second national air-pollution conference at Pasadena, Calif. The scientists suggested proceeding slowly as there is still much to be learned before smog can be combated economically and efficiently; the government officials said to get on with the matter of wiping out the smog. During this argument public relations, sociology, and technical developments, were discussed.

The cost of controlling the smog, the health angle, and the aerodynamics of pollution were included in the discussion.


The special and peculiar air-pollution problems of Los Angeles and its environs are presented. The topographic and meteorological conditions that aggravate the effects of the pollution produced by the greatly increased population and industry are described.

The air contaminants originating in waste farming are discussed in particular.

Tests show that, for each ton of wood material burned, an average of 20 pounds is lost to the atmosphere. In addition to this particulate matter, other products of the combustion of wood in incinerators are aldehydes, ketones, and acids.

If the wood waste is a factor in the total smog problem, what are the alternatives to burning as a means of disposal of wood waste?

These alternatives, as well as the burning of wood waste, are considered. As measures other than incineration that seem to offer a solution, ways must be found to burn the wastes effectively and to cut down on the amount of wood waste produced.


Steel drums are big business—and the reconditioning of used steel drums is also a big business. It is estimated that in 1950 over 420,000 tons of steel were used in manufacturing 25,000,000 new drums, and in the same period 1,000,000 tons, or 60,000,000 used drums, were reconditioned, conserving an equivalent tonnage of steel.

Steel drums or barrels are used for everything from asphalt-base compounds to paints and foodstuffs. Great care is therefore taken in renovating these drums so that, when they are again used, they will be entirely clean and just as acceptable to the food industry or the paint manufacturer as they are to the man who is shipping automobile muffler coats or lubricants.

Long experience has definitely indicated that one necessary step in reconditioning can only be accomplished by burning. When enough temperature is applied to a used drum, some of the residue is softened to a point where it will drop out of the drum, but the remainder is charred to such an extent that shot-blasting will remove all traces of the contaminating material.

The general practice employed in the past violated virtually any smoke-control ordinance. A gas-fired incinerator built by one company was found to do the work successfully.

By the old method of burning drums in the open, it was possible to recondition at the rate of about 200 barrels per day. With the new equipment, the minimum capacity of the incinerator will condition over 400 barrels, with a fuel cost approximately 30 percent of what it had previously been. On this basis, it is indicated that fuel saving alone in the first year should more than pay for the capital investment necessary to build the incinerator.


Incinerator performance is examined from the standpoint of the physical and chemical processes in deep fuel beds, and it is shown that two basic types of burning, overfeed and underfeed, predominate in an intermittently charged incinerator. It is shown that smokeless and odorless combustion of wet charges requires complete control of the rate of feed of the charge, the primary and secondary air streams, and the temperature of the radiant heating surfaces.


Experience gained during the past 25 years by the members of the A. G. A. Subcommittee on Odorization is summarized. Preferred types of equipment and installations, and methods of operation necessary for odor control are indicated. (APB)


Discusses the factors in a successful air-control program carried out in Rhode Island.

Air pollution cannot be corrected solely by persuasion and cajolery. Administration of a good air-pollution-control program requires a sound, authoritative system of permits and fines similar to those that are vital to the proper functioning of a building inspection department, an electrical inspection department, or a health department.
It is helpful to have the backing of mechanical, technical, and fraternal organizations. Particular attention should be given to women’s organizations, because when aroused women will make a stronger and more effective fight for civic improvement. There is no more important factor in a successful air-control program than the friendship of the housewife and the man on the street. Methods used in obtaining their support, as well as that of industrial and other offenders against the air-pollution regulations, are considered.

2169. Dornin, Harry. Japanese Are Smoke Prevention Conscious. High Cost of Fuel Given as Principal Reason. Air Repair, vol. 2, November 1932, pp. 18-20. Describes progress being made in Japan in the adoption of methods and equipment being used in the United States in the steel industry. Control of air pollution is being considered mostly from the standpoint of conserving fuel, which is very scarce and costly in Japan. They fully realize that great economies could be effected by careful utilization of fuel and proper use of the necessary instruments and controls that modern industry in the United States has learned to adopt.

2170. Du Pont, Henry B. Management Looks at Pollution. Air Repair, vol. 2, August 1932, pp. 14-16. The pollution problem has grown up gradually to become recognized as an evil only after it had attained alarming proportions. Pollution is a penalty for the kind of civilization we have built, but it does not have to be permanent.

The greatest promise in abating pollution lies in giving full reign to advancing technology. Real progress will depend on 100 percent participation by the industries and communities in the pointed area.


The principal sources of disagreeable odors in the Los Angeles area are mentioned. Measures taken to eliminate such odors are described. Although the problem has not been solved, much progress has been made, and a number of progressive industries have benefited from resulting alteration of their processes.


A wet-washing plant for cleaning flue gas from coke-breeze-fired boilers is described, but no performance figures are given. The impact on the water of the gas under suction creates a dense water spray, which, combined with the separation effect of the change of direction of gas flow, retains the dust. Circulating currents draw the dust-laden droplets into a still-water region where grit is precipitated. Water entrained in the gas is separated by arrester plates and moisture eliminators at the gas outlet. (APB)

2173. Gas World. New Incinerator at Ministry of Agriculture Laboratories. Vol. 196, 1932. Two separate cremation chambers are built in one block for complete destruction of diseased carcasses and contaminated laboratory waste. In the large chamber, 7 feet long and 3 feet 9 inches wide, eight gas burners are provided, four on each sidewalk. The roof is constructed on the reverberatory principle. When the burners are alight, a high-velocity air charge causes the chamber to be a mass of flame, rising quickly to cremation temperature. The pair of cast-iron, refractory-lined doors over the opening, weighing 7 cwt., are suspended overhead so that they move at a touch and will “give” should there be any explosion from a burning carcass. As the doors open the gas is shut off, and burners are automatically lighted on closing. All waste gases and smoke entering the chimney are filtered through a water-trough dust catcher, operated by centrifugal force, and no solid matter escapes from the stack. It also prevents soot accumulating in the stack. The smaller chamber is similar, but with only two burners. (APB)

2174. Gex, V. E. Odor Elimination at Procter & Gamble. Air Repair, vol. 2, May 1932, pp. 13-14. Considerable time and money have been spent by Procter & Gamble Co. in the past few years in controlling odor emissions from its manufacturing operations.

Although none of the materials discharged presents any health hazards, the company is anxious to maintain good community relations by preventing annoying odors.

The company’s efforts in respect to odor control can be divided into two categories: (1) Development work in methods of odor measurement and odor removal and (2) plant installations made as a result of such development work.

The use of a device, called Osmo, has proved a valuable tool in evaluating odor problems in the factory and in measuring the performance of odor elimination equipment.

The major installations for elimination of odors that the company has made since 1945 represent a capital expenditure of over $90,000 and an operating cost exceeding $400,000 a year.

2175. Gosline, C. A. Planning Prevents Air Pollution. Mod. Sanit., vol. 4, 1932, pp. 17-21, 75. The following steps in developing an air-pollution prevention program are recommended and discussed: (1) Securing management recognition; (2) gathering the necessary data to define most of the process conditions and waste characteristics; (3) estimating potential problems at the sites considered; (4) measuring dispersion coefficients and persistence of stagnant air conditions, and surveying the vegetation at the selected site; (5) developing a waste-disposal flow sheet; (6) applying the foregoing considerations to each process step, building, and equipment pieces as is necessary; (7) giving start-up assistance based on previous determination of critical conditions in order to adjust operating of the waste disposal equipment; and (8) making a survey to confirm the design calculations and provide a basis for further work if needed. (APB)


The importance of publicity and the cooperation between smoke abatement officials and the editors of local newspapers is stressed. (APB)


Air-pollution-control programs require some method of assessing the effectiveness of the corrective procedures. Human observations are subject to many limitations, and their accuracy will be seriously questioned as time passes. Long-period weather cycles, shift in population centers, industrial growth, and changes in chemical processes all produce subtle changes that cannot readily be detected by direct visual observations. Measurements based on a reproducible procedure offer a logical and acceptable means for evaluating pollution levels. Particles are collected on flat filter disks and measured by a well-known apparatus. Limitations and advantages of a proposed
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scale of values for particulate in terms of carbon or
other materials are given. An automatic collecting
apparatus is briefly described. For research studies a
curve of particulate level variation is extremely useful
in analyzing other related data. Air pollution-control
officials can use the procedures for obtaining accurate
comparable data to evaluate the effectiveness of con-
trol measures. Particulate levels and their variations
with time are obtained with a minimum of labor.
Personnel may be used more effectively, as data may
be collected continuously and stored. Later, the most
important periods may be studied as time and im-
portance permit. (AJIHM)

2178. Hodges, John L. The Role of the City in Air
17–19.

Problems arising in the attempt to control air pollu-
tion in cities are presented. In solution of those prob-
lems administration and effective enforcement of a
sensible, practical law, and a well staffed department
with in the city and trained personnel, free of and above
political influence, are important.

Experience has shown that better results can be
obtained by cooperation than by use of the "big stick."
However, there must be an ordinance, and the few
who refuse to cooperate should be prosecuted.

2179. Howson, Charles N. Clean-Air Group Ob-
10–12.

The Smoke Abatement League of Hamilton County,
Ohio, was incorporated under the laws of Ohio on
January 29, 1906, by some 150 citizens "for the pur-
opose of abating the smoke nuisance and preventing
contamination of the air by the dissemination of
noxious gases and fumes into the atmosphere." It
was supported by contributions from citizens and busi-
ness houses.

In 1915, the league, along with 54 agencies, helped
to organize the Community Chest of Cincinnati and
Hamilton County. Since that time the Smoke Abate-
ment League has received most of its support through the
Community Chest, the balance coming from direct
contributions of its 555 members.

Over the intervening years the Smoke Abatement
League has fought for progressively stronger ordi-
nances attacking smoke and for effective enforcement.
In the early years its inspectors made observations,
contacted firemen and plant operators, and, when necessary, prosecuted violators. With appointment of
an official enforcement agency in Cincinnati, the league
broadened its program of education, research and sta-
tistics, and services to promote corrective measures.

The records for the past 2 years indicate reduction
of nearly 11,000 tons a year, or about 30 percent less
than the 36,636 tons that fell on the city during the
12 months ended June 30, 1945.

It is estimated that this 30-percent reduction in
dustfall represents a monetary saving of $2,400,000 a
year in reduced cleaning costs and in protection of
merchandise and property.

2180. Johnstone, H. F. New Engineering Develop-
ments in the Control of Air Pollution. Urban Air
Pollution, pp. 3–13 (mimeo. rept.). Pres. at Industrial
Health Lab., Dept. of National Health and Welfare,
Ottawa, Canada, January 25, 1952.

Two examples of current developments in air-pollu-
tion control are described. One of these is the con-
tribution of several branches of science to identifica-
tion and tracing to their origin of the principal con-
taminants in the Los Angeles smog. This has led to
the control of hydrocarbon losses at the sources, which
is expected to improve the visibility and decrease the
number of complaints from eye irritation and plant
damage. The second example is the fundamental re-
search underlying engineering development of the
venturi scrubber. Theoretical and experimental
studies indicate that, except for the very smallest
aerosol particles, the principal mechanism of collec-
tion is the inertial impact of the particles on the surface of the water droplets during and immediately after the atomization takes place. High
collection efficiencies of dust, smoke, oil fumes,
sulfuric acid mists, and other air pollutants from in-
dustrial operations are now being attained with this
scrubber. (Author's summary) (9 references)

2181. Kaiser, E. R. Factors in Control of Dust From
44–47.

Outlines some of the technical factors involved in
the control of boiler dust and indicates problems in
need of clarification. Describes formation of dust
particles, explains effect of particle density and gas
temperatures on terminal velocity of the particles, and
suggests an interim method of determining their
densities. (APB)

2182. Larson, Gordon P. Ozone Assumes Significant
29–30.

Reference is made to extensive investigations of the
reactions by which ozone is formed when smog occurs in
Los Angeles.

It is clear from experimental evidence, combined
with previously reported work on damage to vegeta-
tion, that certain volatile petroleum products, such as
gasoline, in the presence of sunlight and oxides of
nitrogen, are responsible for reaction products, includ-
ing ozone, which are capable of producing some of the
effects of smog. Their emissions to the air, therefore,
must be reduced to the limits permitted by practical
engineering techniques wherever such sources are evi-
dent in air pollution problems.

As the findings on hydrocarbons are relatively new
and the losses to the air are involved with a broad
aspect of community life, their control will require
additional research. There is every indication that
reliable methods for accurately measuring ozone con-
centrations and atmospheric quantities of hydrocar-
bons will develop from current research. Further
studies will lead to a better understanding of the
specific oxidation products of hydrocarbons.

2183. Marks, John Courtney. New County Control
District Inaugurated Battle Against Air Pollution. Air

On July 1, 1952, the newly formed Air-Pollution
Control District of Jefferson County, Ky., came into
being, and the old Louisville Air-Pollution-Control
Commission was dissolved.

The Jefferson County district will encompass 389
square miles, with a population of nearly half a million
people.

An organization has been set up to finance an air-
pollution study of this area, with a fund exceeding
$50,000 available. Plans are outlined for conducting the
study over a 2-year period.

(Detroit-Windsor Air Pollution Study.) Pub. Health

Industry's cooperation was requested in two major
fields. By circulating questionnaires, information
would be obtained on fuel and fuel-burning equipment
used throughout the area and on sources of gases and
solids discharged into the atmosphere. Industry co-
operates with official agencies in stack sampling.

(PHREA)

Equipment and processes for removing industrial and domestic contaminants from relatively large volumes of air by the use of activated carbon are considered.

It is likely that activated carbon will be one of the most important agents in preventing or controlling peacetime air pollution by objectionable organic vapors and inorganic gases.


The first steps toward actual smoke control in Baltimore were taken in 1932 when the Smoke Control Bureau was organized. Rules were adopted by the advisory and appeal board after public hearings. These rules define tolerances and govern the installation of the various types and sizes of combustion equipment.

The policy adopted by the Bureau “to educate where needed and regulate when necessary” is bringing about a decrease in the volume of prohibited smoke and a general compliance with the tolerances prescribed.


Since 1939 the industrialization of Argentina has made gigantic strides with consequent development of serious problems of pollution from industrial plants. What these problems are and suggestions for their solution are considered.

The struggle against smoke in the city of Buenos Aires has demonstrated that the great cities of the country must attack the problem on the large scale that other countries have found necessary.


Polluted air can be planned out of existence if all the tools available are used. Although control by chaos has been the tradition since the beginning of the industrial revolution, some progress has been made. Some problems encountered and measures for their solution are cited.


Cleveland, long a leader among metropolitan communities for civic accomplishments and industrial achievements, is making a name in the sphere of activity of smoke abatement and air-pollution control.

According to reports of atmospheric surveys in 1946 and in 1951 air contamination in Cleveland has been reduced by 31 percent, with the decline in both total concentration and emission of contaminants varying from approximately 20 percent in some areas to 50 percent in others.

This substantial reduction is said to be due to reduction of smoke and modernization of firing equipment in city schools, public buildings, and institutions; to important steps taken by Cleveland industries toward correcting air pollution; and to the division of air-pollution control, which has done a thorough job of inspection and has succeeded in obtaining the cooperation of industry and others in abating smoke and curbing air pollution.

Industry in Cleveland has spent $30,000,000 since 1946 for modern combustion equipment and new control devices designed to reduce “neighborhood nuisances” from atmospheric contamination.


Air-pollution control in Pennsylvania is under the State health department’s bureau of industrial hygiene. There is no statewide air-pollution law in Pennsylvania, but there are rules and regulations governing public-health nuisances that prohibit the escape into the air of noxious gases that are deleterious to health. However, the standards defining them have not been established by legal code or general acceptance in the field of air pollution investigation.

After evaluation of the potential health hazard, it has been the practice of the bureau to attempt to convince management of its responsibility to the community in abating air-borne industrial wastes as much as is practicable. Also, the factual and unemotional statement of conditions are presented to the public, usually through local municipal authorities.

Organization of the bureau of industrial hygiene, with its laboratories including mobile traveling units, is described.


This memorandum of the National Smoke Abatement Society to the Sanitary Inspectors’ Working Party states that smoke control under the public health acts should be made as effective as possible; all sanitary inspectors should have a basic qualification in atmospheric-pollution prevention work comparable with the present smoke inspectors’ certificate, and an improved smoke inspectors’ certificate should be obtainable by those specializing in smoke-abatement work. (APB)


The Aramingo area of the city of Philadelphia contains much land that is potentially valuable as sites for new industrial plants. For many years, however, it had not shared in the general industrial growth of the city. Realizing that the odors, fumes, and other air contaminants produced in the area might well be depressing its property values and hindering its development, the city sponsored a 1-year research project by the Franklin Institute Laboratories for Research and Development.

The purpose of this project, which was begun in July 1950, was to obtain technical information needed in making plans for alleviating odor and fume problems of the area.

It is apparent that odors from virtually all other sources can also be collected and analyzed by the methods described. In most instances, once the nature of the chemicals causing specific odors is known, field detectors can be built and methods of abatement worked out if needed.

It is believed that the most valuable part of this work may be the demonstration that the chemicals responsible for odors can be dealt with scientifically as air contaminants and as such are subject to routine regulation and abatement methods.

The extension of this work to include all the major types of odors in the locality, and to establish scientific bases for their regulation and economical abatement, is recommended as a practical, possible, and fruitful step toward alleviating the odor problems of the Philadelphia area.


Facts, not fantasies, should guide the policies of city governments in controlling air pollution, a problem for the engineer rather than the over-zealous reformer.
The article discusses haphazard legislation, unsubstantiated charges against smoke causing serious injury to health, and economic considerations from the viewpoint of the industrialist and public. (APB)


The paramount requisite for continuous prevention of objectionable odor concentrations in outdoor air is the structural confinement of odor-bearing air at its source. This can only be achieved by effective enclosure of the odor source to enable conveyance of all the contaminated air or gas through an effective cleaning system. Failure to construct buildings or enclosures tightly and to exhaust them at a rate that will insure inward airflow at all openings is then equivalent to inadvertent bypassing of the air-treatment equipment.

Dilution of contaminated gas does not reduce the total mass of odor material discharged and is therefore an ineffectual procedure. If, however, additional air is used to provide substantial increase in the upward velocity of exit from an exhaust stack, the odor intensity in the immediate vicinity may be noticeably reduced. Frequency of unfavorable weather will determine the value of dispersion procedures in each locality.

Injection of masking substances (nonreactive and nonabsorptive) into the air before discharge will rarely succeed.

The amount of odor in the vents from buildings and processes can be reduced by: (1) Change of process ingredients, (2) passage of gas through a combustion chamber, (3) injection of a reactive substance into the gas before discharge, (4) suspension of a finely dispersed solid sorbent in the gas with subsequent separation of particulate sorbent, (5) filtration of the gas through a bed of granular sorbent, and (6) passage of the gas through a scrubbing tower or chamber.


Expansion of the work on the abatement of smoke from burning fuel to cover the study of air pollution from any airborne effluent is described.

Projects at Battelle in air-pollution research are being carried on for a wide variety of industries. They include not only utility companies but also various chemical manufacturers and metallurgical industries. Research programs currently in progress range in size from those around individual plants to those covering a whole city and involving the study of a very complex mixture of air pollutants.


Tower scrubbers are discussed as devices for removal of particulate matter vapors from industrial gases. Scrubbers are shown to be inefficient for particulate matter but efficient for vapors. The desired properties of solvents, both reactive and nonreactive, are listed along with a discussion of the problems of disposal or regeneration.

The basic theory and operating principles of absorbers are outlined, with emphasis upon the important design factors of liquid-gas ratio, height, and diameter. Different types of equipment are described and illustrated with comments as to inadequacies and restrictions of design and structure.

Limitations, both technical and economic, of absorption systems for control of air pollution are discussed, with reference to other equipment where useful.

MECHANICAL AIDS

1854


Describes automatic air-supply valve, which regulates the admission continuously in a diminishing rate, according to the quantity required by the state of the fuel. (MIR—Bib.

1855


Heat is screened from ashpit by iron plates. Air entering furnace is therefore cold and unarreled and for this reason is said to produce a more intense and rapid combustion. (MIR—Bib.

1857


Air is admitted downward directly over furnace bridge and the supply automatically regulated. Apparatus is said to prevent smoke. (MIR—Bib.

1858


Account of competitive selection of apparatus for smokeless firing of a certain boiler. Of 105 devices submitted, 4 were tested and are described. The successful type—the Williams furnace—is arranged for alternate side firing and admits air by means of jets. (MIR—Bib.

1866


Air is automatically regulated at bridge, air-admission valve being operated by flow of water from one vessel to another. (MIR—Bib.

1867


1872


In each tube of an ordinary tubular boiler is inserted another of much smaller diameter perforated at the end nearest the fire in such manner as to cause an induced draught. (MIR—Bib.

1873


1880


The Board of Commissioners of the Cincinnati Industrial Exposition (1879) offered a prize of $500 for the
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best furnace system for steam-boiler used designed to burn bituminous coal without smoke. This paper reports the trials of the five competing types. (MIR--Bib.)


Principle of the invention of A. C. Engert is the division of the furnace into two parts. The coals are fed into the front part upon a thin stratum of live fuel, and the gases directly rising from them are drawn into the other part of the furnace and consumed so that no smoke can be formed. (MIR--Bib.)

1881


Describes and illustrates a furnace for "prevention" rather than "consumption" of smoke. Advocates application to domestic fires and to locomotives. Furnace is equipped with a double door designed to prevent admission of cold air to firebox. (MIR--Bib.)


Describes A. C. Engert's application of continuous firing to hand-fired domestic or steam-boiler furnaces. Coal is fed at back of furnace or movable plate, which is pushed forward at intervals, thus replenishing fire by coal which has been slowly heated. (MIR--Bib.)

1882


Describes a very simple device whereby smoke evolved by the coal used under ordinary steam boilers seems to be effective in preventing the escape of unconsumed carbon from the smokestack.

The brick wall is built close to the boiler and pierced only by a vertical slit extending from the bottom of the firebox to a point a few inches below the boiler. The draft of the chimney, the size of the boiler, and the number of flues must all be considered in determining the dimensions of the slit, but once correctly proportioned it seems to concentrate the smoke and gases of the furnace, with the air admitted through the grate, in such a way as to obtain perfect combustion of the carbon and flammable matters evolved. All the furnaces in use at the waterworks have been altered in accordance with this new principle, and an important economy in coal, amounting in one instance to about 20 percent, has been effected, in addition to the saving of annoyance by smoke.

1885


Economy of furnace, which used forced draft, was good, and operation was virtually smokeless. (MIR--Bib.)

1890


Experiments illustrate theory of combustion and smoke production. Necessary requirements of mechanical devices for preventing smoke are outlined. (MIR--Bib.)


Gives results of tests in Greaves apparatus. (MIR--Bib.)

1891


Trials show that with the apparatus in use the evaporative efficiency of the boiler is increased 20.5 percent, and the amount of smoke is greatly reduced. (MIR--Bib.)


Main object of device described is to furnish a secondary supply of heated air, introduced at the back of the fire bridge. (MIR--Bib.)

1892


Discusses "an invention called the complete combustion boiler," giving arguments for its adoption. (MIR--Bib.)


Considerable success was obtained with this apparatus, which admits secondary air supply through wire gauze of specific mesh. (MIR--Bib.)

1893


Based on automatic regulation of air supply. (MIR--Bib.)

1894


Considers requirements of smoke-preventing appliances and classifies and briefly describes method under following heads: Steam jets, firebrick arches, hollow walls for preheating, coking arches, double combustion, downdraft furnaces, and mechanical stokers. (MIR--Bib.)

1896


Briefly gives characteristics of different devices. (MIR--Bib.)

1898


Describes instrument known as the Economist. A detailed discussion of the operation of the Economist was submitted. The Econometer works continuously and shows automatically the percentage of carbonic acid in the gases, thus enabling the firemen to see at all times the more or less favorable conditions of combustion.


The more hot gases that could be carried into the flue the less smoke would be emitted. (MIR--Bib.)


Discusses results of Technical Commission's investigation in Paris. The commission conducted a competitive test of 110 forms of smoke-preventing apparatus, classified in eight divisions. (MIR--Bib.)
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1899


Discusses the report of a special committee to the Engineers’ Society of Western Pennsylvania, appointed to inquire into the prevention of smoke in Pittsburgh. Reduced to its simplest terms, the report is not much more than a restatement of the facts that incomplete combustion produces smoke, that mechanical is better than hand stoking, and that improved furnaces tend to insure perfect combustion. Engineers are expected to provide apparatus that can be relied upon to cope with a known difficulty in a practicable manner at a reasonable cost.

1903


Shows efficiency of the “hydrocarbon system” of the Steam Boiler Equipment Co. of New York. Does not describe system but gives charts indicating elimination of smoke due to its use. (MIR—Bib.)


First apparatus is the invention of J. B. Harris for stationary boilers; air is forced through an iron-pipe air heater in furnace wall by a motor-driven blower. Second apparatus is a locomotive firebox with swing-up partition arranged for alternate side firing. (MIR—Bib.)

1905


Describes device in which air is automatically admitted into firebox just after green fuel has been fed to fire. (MIR—Bib.)

1906


Directs attention to the engineering phase, emphasizing certain fundamental principles. Lengthy discussion includes drawings of many furnaces and stokers. (MIR—Bib.)

1907


Gives conditions for perfect combustion and methods of burning fuel. (MIR—Bib.)


Compares trials of two water-tube boilers and shows the improvement due to use of a tile roof above the furnace. (MIR—Bib.)


Abstract of lecture before International Association for the Prevention of Smoke at Milwaukee, Wis. (MIR—Bib.)


Describes device that claims to burn any kind of fuel without smoke. (MIR—Bib.)


Gives principles of combustion and details of firing arrangements of furnace and stoker. (MIR—Bib.)

1908


Discusses design of furnace and proper methods of firing. (MIR—Bib.)


Describes tests of boiler settings of Chicago school buildings. The city smoke-inspection department claimed that the schoolhouses using soft coal were among the worst smoke producers. Tests were made of boiler settings with and without low-arched fireboxes. Results of observations of smoke density made with Ringelmann charts show slightly less smoke with low-arched firebox than with standard design formerly used. With the expert firing during test, neither smoked seriously. (MIR—Bib.)


Presents principles of combustion in popular form and enumerates chief causes of smoke. (MIR—Bib.)


General statement dealing with fuel waste and brief discussion of advantages of gas producer. (MIR—Bib.)

1910


States briefly that smoke is in large part unnecessary and uneconomical. (MIR—Bib.)


Describes furnace with special firebrick arches. (MIR—Bib.)


Specially designed furnaces and skillful firing are given as the only solutions for the prevention of smoke from high-volatile bituminous coal. Automatic stokers are recommended. (MIR—Bib.)

1911


A smoke consumer in use in England, reported to be satisfactory, is described briefly. An important claim is that the apparatus can be affixed during the weekend to almost any type of boiler.

1912


Discusses principles of design, claiming that in many instances where boilers and furnaces are condemned for bad performance the trouble lies entirely in faulty design of breeching. (MIR—Bib.)


Smoke production was diminished by addition of hot surface, with checkerwork. (MIR—Bib.)

Forced draft is said to reduce smoke to minimum. Plant of the Stadt Elektrizitätswerke Lichtenberg is described. (MIR—Bib.)

1913


Describes W. C. McClurg's patented process for complete combustion. Designer abolished grate bars and provides greater for feed and water. Diagram shows results of tests. (MIR—Bib.)


St. Louis has a strict smoke-prevention ordinance, and the fireman who shovels coal carelessly, with consequent clouds of black smut from the stack, is likely soon to find the firing aise blocked by a couple of bluecoats with shining nickel-plated stars. The ordinance has been of assistance to the Union Electric Light & Power Co. in transferring isolated plants to its care, where they receive scientific, intelligent supervision. For instructing its firemen in proper cooling methods at the old Imperial district-heating plant, 10th and St. Charles Street, a 36- by 36-inch plate-glass mirror has been mounted on a framework in the yard outside the boiler room, so that the top of the smokestack can be seen from any point in front of the boilers. Ringelmann's charts of smoke density are posted conveniently near, and the fireman can take observations from time to time without leaving his station.—Electrical World.

1923


Various methods of handling ash are discussed and illustrated by drawings and diagrams.

1926


Discusses what has been accomplished and what the future possibilities are for the use of the smokeless operation of the oil-electric locomotive.

Describes oil-electric equipment and performance characteristics.

1927


An apparatus is described for purifying air and regulating its temperature and humidity by mechanical means. This apparatus has been used to remove CO₂ from vitiated air, as in the compartments of a submarine, and for removing particles of dust from the gases of combustion in a chimney.

1933


Discusses flue gas heat losses when oil is the fuel.

1935


Discusses steam pressure and furnace draft regulators, individual and master controllers.


Discusses the purpose of the compensator used in connection with steam and furnace pressures or draft regulators described in a previous article in Power Plant Engineering, vol. 39, No. 4, April 1935.


Describes the "A-jacks" control of the National Regulator Co. for boilers operating at 15 to 300 pounds pressure.

1925


Describes the step-action hydraulic regulators, as used for boiler control, constant and variable stop compensator, and undervoltage release for motor protection.


Describes a balanced draft control for underfeed stoker-fired boilers.

1927


Describes the overfire-underfire system of the Carrick Engineering Co. for small and medium-sized boilers.


Describes "on and off" stoker control, thermostats, pressure switches, low water cutoff, air damper control, interlocked or sequence damper and stoker control to prevent blowback, and pressure control of gas-fired boilers.


The extension to the Richmond Station of the Philadelphia Electric Co. has a complete system of combustion control and automatic control of raw-coal feed to the pulverizers. To obtain a wide range of speed control for the forced-draft and induced-draft fans, they are driven by constant-speed motors through variable-speed hydraulic couplings. A diagram shows a cross section of a hydraulic coupling such as is used.

1936


Describes mechanical ash-handling equipment.


Explains all types of regulation for combustion, starting with the simple types used on house-heating boilers and finally leading up to the more complete system as employed on power boilers in industrial plants. The discussion is confined to the principle on which they operate rather than to an attempt to classify and describe each in detail.

1937


Describes the various means of dustless ash removal in boiler plants, showing how this method both simplifies and also cheapens boiler operation.


The method used in eliminating emission of soot, when the soot blowers are turned on, is described in detail. The diagram shows a section of the chimney and soot eliminator.


The coal is followed from the hopper through the furnace in the hope that it will lead to a clearer understanding of the relationship of the type of coal, the size of coal, and other characteristics to performance.
1938


Five classes of devices and equipment are discussed in treating gases that may pollute the air from various sources. These are settling chambers, mechanical collectors of various types, scrubbers, filters, and electrical precipitators. The use and efficiency of these types of equipment are considered in some detail.

An interesting development is the use of fly ash as a puzolanic material in making concrete, which has proved to be advantageous. The expectation is that in time the fly ash collected will be a means of revenue rather than a source of expense in its disposal.


The bag method consists in extracting a certain volume of gas from the main gas stream and passing it through one or more bags in which the dust is filtered from the gas; these bags weighed before and after the test to determine the exact amount of dust in the gas. Where the gas has a high moisture content and precipitation occurs, it is necessary to dry the bags and contents before weighing.

Although the bag test will not operate at 100 percent efficiency, it is accurate enough for industrial purposes, as virtually all of the dust particles are trapped.

1939


At the Schuykill Station at Philadelphia a new installation of two 910 F. pulverized-fuel-fired boilers, with a capacity of 600,000 pounds per hour at 1,350 pounds pressure, were completed in October 1938. They are of the continuous slag-bottom type equipped with electrostatic precipitators. Each boiler burns about 27 tons of coal per hour. This article describes the method used for the disposal of slag as well as fly ash.

1940


The working principle of the ejector is explained in detail and illustrated with diagrams. Formulas are derived for calculating the performance of the ejector. This apparatus is best suited for eliminating any material that is extremely corrosive, explosive, hot, or sticky. It may also be used for abrasive materials or for nuisances or hazards that are created only infrequently and may be operated by using steam, water, or exhaust gases, the latter when available under a few inches of water-gage pressure, providing especially economical. (JHHT)

1945


Reviews the work of the Fuel Council for War, composed of virtually all the companies manufacturing automatic-control equipment for heating and steam generation.

Analysis of the results of the use of control equipment clearly demonstrates a considerable saving in fuel, much more efficient boiler operation, and smokeless or virtually smokeless operation. The relationship of control equipment to smoke elimination is very close. A boiler that smokes wastes fuel, and it smokes because it is not properly controlled.

Various types of control installations are discussed.

1946


Briefly reports material progress in smoke abatement in Alexandria after a 2-month campaign to enforce the city's antismoke ordinance. Smoke-consuming devices have been installed on 22 locomotives in the railroad yards, a bolt of $400 each. Smoke devices have also been installed on all boilers in the power plant connected with the yards, and steps are being taken by the Southern Railway to equip all its engines, laboratory, and power plant with such devices.

1947


In a modern refuse-disposal plant smoke pollution is negligible owing to the type of material fired and the use of a postcombustion chamber for gases. In spite of prescreening, however, a large amount of fine dust is added to the flue gas. A dust trap of some kind is necessary, usually of the water-impingement type, which operates effectively on the low gas velocities normally employed. (FA)


To abate any "smog" conditions at its Torrance, Calif., refinery, General Petroleum Corp. developed a system for burning waste gases by using a venturi-type aspirating burner. For burning isobutane vapors, for example, a ratio of venturi throat area to gas orifice area of 4 to 1 was found adequate; for gases containing up to about 20 percent of unevaporized hydrocarbon it was found necessary to increase this ratio to 16 to 1. Flames did not "pop back" to the gas orifice at gas pressures as low as 3/4 p.s.i.g. A series of burners of different sizes was installed, controlled automatically to go into and out of service as gas pressure varies. The installation has given satisfaction in eliminating smoke nuisance. (FA)


Describes equipment developed in laboratories of Pennsylvania Salt Mfg. Co., by means of which deposition, adhesion, drifting, rate of settling, and toxicity of dusts may be studied. (FA)


Eight houses have been built at the Building Research Station for the joint purpose of research in house construction and full-scale tests of the heat requirements of houses insulated to different standards. The objective was to obtain experimental evidence that would help in assessing the amount of insulation which is worth while and to ascertain how the heating of a house insulated to the building committee's standard compares with that of an "uninsulated" house. The heating system installed, one of the various combinations considered for postwar houses, was selected as an experimentally convenient example of an installation using solid fuel; the heating appliances do not need constant attention. Background heating is provided by embedded ceiling panels in the living room and the parlor, which serves also as floor panels for the two main bedrooms; and the living room is "heated up" by an electric fire. Hot water for the panels is supplied, through a heat interchanger, by a boiler that also pro-
vides the domestic hot water. The houses and heating equipment, the experimental arrangements, including equatorial-rotation, and the experimental results are described. The cost of insulation can justifiably be incurred, in addition to the normal cost of building, because of the substantial saving in heating cost. The experiments confirm that, if the additional initial cost does not exceed $500 for a house, the maximum values of thermal conductance put forward by the Committee are reasonable and that still lower values are to be preferred where they can be obtained economically. Eliminating topping up by an electric fire, warming the living room solely by the central heating installation proves advantageous. (APR)


Describes the work of the Fuel Efficiency Division of the Ministry of Fuel and Power, which is divided into two sections, one dealing with domestic use of fuel, use of fuel in the home and in flats and office buildings, and the second with industrial use in factories. In the survey of domestic uses of fuel the design and production of improved types of appliances and their correct installation in new and existing houses are considered. In determining the industrial aspect, the problem of grit emission is discussed, and cyclone-type grit arrestors are described briefly. The training of stokers is considered. (FA)


The report refers to smoke and gas that issue from coke ovens during charging and points out that it is a serious matter and is likely to become more so with the increasing tendency to build coke ovens in populous areas. Speedy charging reduces the time during which the emission continues, and the volume may be limited by the use of steam jets in the ascension pipes and by interconnecting flues on the oven tops. These are palliative measures that can readily be adopted even on the older batteries, but the only method that seems to hold out hope of real success is the provision of double collecting mains; these, together with the provision of the best mechanical aids to charging, should not present insuperable difficulty in erecting new installations. It would seem justifiable to grant permits for the building of new ovens or the rebuilding of old ones only on the condition that the best practicable means should be employed for preventing the emission of smoke, gas, and grit to the atmosphere. (FA)


Discusses dusting systems—dust chambers, haffle separators, centrifugal separators, cyclones—advantages of the cyclone type, and influence of particle size; gives views on the choice of a system. (FA)


Loss of boiler capacity plus smoke troubles made a New York operating engineer introduce furnace and combustion-control changes to carry process and heating with less fuel and smoke-free stack. The boiler plant is described briefly. A change in furnace design improved combustion by introducing added turbulence beyond the bridge wall in the path of the gas. This was provided by building a firebrick lining within the furnace chamber beyond the bridge wall. The lining narrowed the flue-gas exit path and produced a more intimate mixture plus a change in direction of the flue gases. Photo-electric combustion control was installed, with a consequent reduction of 14 percent in the previous fuel consumption. (FA)


1948


Two types of scrubbers, the Wet Cyclone P-A and the venturi, are described. These methods are not used to control smoke from poor combustion, as it is cheaper to conduct the combustion so that smoke is not made. There are many metallurgical and chemical operations, however, where such combustion is not possible, and dusts, fumes, smokes, mists, and acid gases must be removed and the odors absorbed.

Various installations of the two types of scrubbers are discussed. However, other ways to reduce air pollution are often recommended for a specific application when better overall economy is indicated. (15 refs. cited)


Presents schematic views and description of the wet cyclone and venturi scrubbers. Basic patents of each have been granted. Typical installations of the wet cyclone are described, and the operating characteristics, efficiencies, and limitations are given. A fairly extensive bibliography covering this device is included. The newer venturi scrubber is described more fully, and experimental work in progress to determine the fundamentals of theoretical design of these units is mentioned. Pilot and production units now in operation are summarized and efficiencies of collection and collecting data tabulated for those units. Several electron micrographs of materials being collected by these units and a number of photographs of the spray pattern of collecting fluid formed in the throat of the venturi scrubber supplement the description. (FA)


This booklet describes the firm's ash- and dust-handling equipment, starting with the simplest form for a limited number of boilers, then layouts for the larger installations, finally, equipment designed for the largest central power station. The disposal of the large quantities of dust collected in connection with pulverized-fuel firing and modern methods of dust catching are treated separately. (FA)


The invention relates to a device for separating a furnace from a combustion space by means of a bridge formed of a plurality of contiguous sections, each provided with an outlet for the introduction of steam and air into the combustion space for the purpose of consuming any unburned gases; the steam, preferably superheated, is supplied to the various sections through a plurality of outlets in a communal steam pipe. (FA)


Automatic systems using photocells and relays have virtually eliminated smoke and resulted in fuel savings
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of almost 20 percent on oil-burning boilers of Harvey Hubbell, Inc., Bridgeport, Conn. (FA)


A smoke eliminator designed and developed at the Fuel Research Station was shown at the Engineering and Industrial Equipment Exhibition at the Royal Horticultural Hall, Westminster. Fitted to an ordinary boiler, it has been found to save at least 10 percent of the fuel consumed, and to eliminate much of the smoke that pollutes the atmosphere and wastes fuel. The smoke eliminator is a simple furnace door, which regulates the flow of air over the fuel bed. By allowing the use of the maximum amount of combustible gas, the eliminator is making a great contribution to the fuel-saving campaign. Present fuel saving with these doors has been reckoned at 20,000,000 tons a year.

About 100,000 doors are being sold each year. (FA)


This paper deals with the smaller type of steam plants, those generating approximately 3,000 to 20,000 pounds of steam per hour output or consuming 1,000 to 8,000 tons of coal per year. Benefits of instruments and combustion control are discussed as well as their possible arrangement to fit the individual plant requirements.


Measures taken for reducing the emission of air-polluting particles are discussed. Old boilers are gradually being replaced by new ones, which produce little or no smoke owing to the equipment and methods used and the type of fuel burned. They are fitted with automatic combustion controls, such as fuel meters, fuel-air-ratio controls, furnace-pressure and temperature controls, and, in some, gas-pressure regulators. Fuels used include coke-oven gas, fuel oil, producer oil, producer gas, and low-volatile coal. A sintering plant is used to process blast-furnace fine dust and ore fines into sinter for charging into the blast furnaces, and the sinter fines themselves are collected and used. Combustion gases from various sources are drawn through hoppers in which larger solid particles fall onto a conveyor belt and are taken to the sinter plant; the remaining gas is put through a cyclone cleaner to remove additional particles, and is finally subjected to equipment of a mechanical design similar to that used for boiler fly-ash removal. The author also discusses sources of smoke other than the steel plant, such as river boats and locomotives used for transport and other sources in Pittsburgh responsible for air pollution. (FA)

1949


A catalytic process of combustion promotion, using catalysts essentially of the terpene hydrocarbon series, has been developed. These are transported into the reaction zone by a small quantity of low-pressure steam with the secondary air. The catalyst actually promotes the separation of the component gases and allows recombination at a much lower temperature. Catalysis changes the flame from a long, reddish, orange, smoky one to a short, intense, dazzling, white flame having quite a different sound from the original. The process may be installed in any type of boiler and can be applied to heavy oils and sludge as well as bituminous coals and sawdust. (FA)


"Catecal" is a catalyst that promotes complete combustion and thus reduces smoke and hard-clinker formation. It is employed efficiently in several Toronto works. (FA)


Complaints about the delay in erecting the grit-arresting plant at Fulham Power Station are mentioned. The work being done and still to be done is described. (FA)


The 84th Annual Report on Alkali Works (H. M. Sta. Office), which contains a section dealing with electricity-generating stations, is reviewed. It has become an accepted standard that stoker-fired boilers shall be furnished with efficient grit arresters of the cyclone type and that the electrostatic precipitation plant shall be provided for pulverized-fuel boilers. These provisions and the use of high chimneys are a safeguard against heavy deposition of grit and dust. (FA)


A short description of a type of grit arrester produced locally, with a plea for a standardized design to be issued by a central authority. (FA)


With the increasing use of overfire air jets for smoke abatement, renewed interest has been shown in the effect of overfire air and added furnace turbulence on furnace performance. Describes test work carried out by a number of companies using these jets; concludes that improvements in furnace performance have been shown on all types of stoker-fired and hand-fired furnaces by the use of overfire jets. Maximum benefits from jets are most likely to be obtained in furnaces fitted with a fan and spreader stokers; if there is no auxiliary turbulence from jets, as in various types of furnaces, the benefits include substantial reductions in smoke density, increases in boiler and furnace efficiency, reduction of both the quantity and carbon content of the cinder carryover, shortening of the flame and reduction of the final temperature when surfaces are of the same degree of cleanliness, reduction of soot and slag deposits on boiler and economizer surfaces, and ability to operate with slightly lower excess air without unburned combustible gases. (FA)


Two units are described, a cyclone dust catcher followed by a heat exchanger and a combination dust catcher and heat exchanger.


1950


Equipment now in use for removal of dust and fumes from industrial effluents is discussed. The following main headings are considered: (1) Bag houses and filters, (2) Washers and scrubbers, and (3) agglomerators. Their applications to various industrial processes are considered. (APB)
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Electronic eyes that never sleep are on constant patrol to see that no black smoke escapes up the stack at the brush division plant of the Pittsburgh Glass Co., Keene, N. H.

As soon as the smoke in the stack reaches a certain density, an electric eye located at the entrance to the stack kicks on a big fan. Jets of air are forced into the fire, providing better combustion and reducing smoke almost to zero.

The plant was praised highly by the Keene Evening Sentinel for its operation on the outskirts of industry, which makes it a true part of a city instead of only a resident therein.


A new catalytic process for smoke elimination from boiler plants is described briefly. (APB)


Describes a wet washer for scrubbing gases emitted by a cupola and gives details of its operation and efficiency. (APB)


The venturi scrubber for controlling air pollution by removal of solids down to micron size from effluent gases is described. Its advantages are proved efficiency, moderate overall cost, and simplicity of operation and maintenance. The claim is made that it is a superior primary washer at moderate pressure drops, where secondary cleaning follows, and may combine the functions of a primary washer and a fine gas cleaner when operated at higher pressure drops. (APB)

1952


The Houardy process of "catalytic cracking" is discussed with regard to its elimination of waste gases and odors from industrial and other chimneys. The successful elimination of disagreeable stench from the stack of an enamel-baking plant is given as an example of the magic of Houardy's process in eliminating odors and other pollution. The process also saves fuel as the heat escaping up the stack is channelled back to the original furnace. The fuel saving for the enamel company is expected to pay the cost of installation in 6 months.


This cleaner comprises parallel cylindrical separator tubes placed at least 45° to the horizontal and means for imparting helical motion to the dust-laden gases entering them. In its application to furnaces, provision is made for returning the coarse dust to the furnace. (APB)


Presents a case history of the methods the Pennsylvania Salt Manufacturing Co. has used in controlling air pollution by the absorption of acid vapors produced by its HF acid plants.


Cites boiler plants in which some details in assembling it were overlooked and thereby left a trail of smoke. The small plant in the 22- to 500-hp. range is considered primarily. In this smaller range boiler plants often are assembled without the assistance of the professional design engineer.

For a number of years the Cincinnati Bureau of Smoke Inspection has made a check on the causes of smoke violations. In 1946, 48 percent of observed smoke violations were attributed to such causes as misapplication of combustion equipment, obsolete equipment, and poorly maintained equipment, that is, causes other than improper operation. In 1949 the first annual inspection of coal and oil-burning commercial and industrial plants was made as required by the antismoke ordinance. Of a total of 4,500 plants inspected, more than 1,000 had major defects: 100 plants had broken, warped or no cleanout doors on breechings and chimneys; 186 plants, which were required by the ordinance to have smoke indicators, had no means of observing their chimneys or no smoke-signaling equipment; 236 plants had no settling chamber in the base of the chimney; and 198 plants were choked with soot and fly ash.

Concentrated effort has reduced visible smoke violations and greatly improved plant conditions. In 1961, 26 percent of observed plant violations were attributed to causes other than bad operation. On annual inspection only 196 plants were turned down for major defects.


Two installations for the mechanical removal of dust from boiler flues are described briefly, a blower to dislodge the dust and a suction device to collect it. (APB)


Describes equipment available to industry to prevent air pollution. Characteristics and applications of each type of collector are explained, along with their limitations. (APB)


Since 1946 considerable interest has been shown by Cleveland civic, municipal, and industrial groups in the field of air-pollution control. It is generally
understood by those who have worked in the field of air pollution that toxic limits are fairly well established for certain pollutants.

The nuisance factor to other industries, home owners, and residents of the area can be determined only by obtaining their reactions to the various waste products discharged. An understanding of the problems by these people is most helpful.

As a part of the municipal program, potential sources of air pollution from refinery operations were investigated and the technical work discussed and reviewed. The main cost of all groups concerned led to a rapid economical solution of potentially serious air-pollution problems. Three major sources of possible air pollution in the Sohio operations are discussed in detail.


The success of overfire air systems is due to careful engineering for each individual installation. The use of the Pl-O-jet is described. The system is adaptable to several methods of control, including manual, semi-automatic, automatic, and electronic. Pl-O-jet overfire air systems are more economical than steam jets, since the use of steam represents a needless waste of expensive fuel and a reduction in boiler capacity. Pl-O-jet uses air, available in abundance, without cost, and electricity to operate the turbo-blower.

Pl-O-jet eliminates smoke—which is really nothing but unburned coal—by providing the air and turbulence required to burn that fuel and achieve complete combustion.


Legislation to reduce atmospheric pollution is to be introduced into Sweden, and the article is intended to guide prospective purchasers of dust separators. International permissible dust-emission levels are compared, effect of grain size on separation is outlined, and densities of various dusts are given. Principles of cyclone-type separators, filters, scrubbers, sonic-wave agglomerators, and electrostatic precipitators are briefly discussed, and factors that govern choice of method, including space and maintenance requirements are mentioned. (APB)


A company that manufactured varnishes, enamels, and paints made a survey of other plants to determine the best method to eliminate fumes that would be objectionable in a hospital, school, and residential district for which it was moving its plant.

The specifications drawn up to embody the good points of the various types observed are outlined. A unit was adopted and has been in successful operation for some time. It has completely consumed the fumes generated during the processing of different types of obnoxious varnishes, alkyl resins, and bodied oils.

The system functions according to a physical law that a combustible gas, regardless of its dilution, which might ordinarily render it incombustible (in the mixture), is consumed when exposed to the surfaces of a suitable catalyst. This is a new application of the law that has been utilized for many years in the manufacture of gas detection instruments and in oxidation reactions in the chemical field.


Houdry catalyst unit consists of a brick plus 73 porcelain rods coated with catalytic alumina and platinum alloy. This coating completely oxidizes combus-
tibles even at temperatures well below their normal burning points and generates enough waste heat to fire boilers and heat plant processes. Highly satisfactory experiences of Enamelstrip Corp., Allentown, Pa., in using the catalyst units in the paint-drying ovens are described. (APB)


This invention relates to an improved cyclone separator. The cyclone contains dust-disengaging baffles in the dust-collection chamber, which more completely separates the dust from the upward flow of gas leaving the dust hopper. (APB)

1893


The deficiency of light on Sundays in the Hulme district being as great as on weekdays proved that the pollution of the atmosphere was due largely to domestic fires.

Manufacturers were said to contribute about 200 percent of smoke pollution in large towns.

The alternatives were to burn either gas, anthracite, or ordinary coal in an improved grate; the improved grate was thought to be the only solution.

The hydrocarbons produced and voided through the chimneys were paraffins, not benzenes.

1907


Prevention or mitigation of the smoke nuisance from private houses could be attained by alteration of the structure of the grates and by change of fuel.

The effects on vegetation and health are mentioned, as well as the high annual cost of cleaning the surface of the Houses of Parliament.

1918


Two significant facts were observed in connection with using chain grates: (1) Even in the absence of adequate furnaces, chain grates were good performers in that they produced little or no smoke; (2) boiler tests indicated high hydrocarbon losses due to insufficient space for their combustion.

1929


The greatest value of the phrase "a practical solution" was in the criticism that it evoked from the audience.

The recommended grate, although not so ill looking in its special setting, would be tolerated by a few middle-class folk for the usual type of fireplace in which it is so unsightly. Moreover, the fire can scarcely be seen behind the mass of ironwork—that there is no effective radiation of heat at foot level—while the "gas poker" is not only a clumsy device, which increases expense, but is quite unnecessary if suitable, dry-quenched, graded coke is used.

For the average small home, not only is the cost of this type of grate too high as a replacement but it would be much increased by the bill of the plumber
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for connecting the gas poker to the nearest gas pipe, which more often than not is some distance from the fireplace. Even though they have its advantages, very few poor families could afford this initial outlay.

At present many large towns—for example, Manchester, Glasgow, and Sheffield—are selling every ton that they can produce of graded, dry-quenched coke that will burn, without any gas-poker aid, in existing grates or on flat hearths. A practical solution of the smoke problem may, perhaps, lie in the increase and cheapening of such existing supplies of low-temperature coke, as has been suggested. (BH) 1930


A grate has not yet been designed that will eliminate smoke. The fireman and the engineer are at the head of the list in the problem, but a proper grate design can be a decided help.

The results of experiments with the standard Hulson grate are described. 1945


A resolution was recently passed by the Executive Committee of the National Smoke Abatement Society in which the committee expressed its grave anxiety at a situation that will result in a great number of new houses being fitted with solid-fuel-burning appliances of obsolete type and inferior efficiency. This must mean that: There will be further wasteful consumption of solid fuel during a period of continuing scarcity; the occupants of new houses will be faced with permanently higher fuel costs; and the smoke evil will be extended and intensified. The committee has noted the parliamentary reply on behalf of the Minister of Fuel and Power (June 13) to the effect that the fuel so wasted will be of the order of 1 ton per house per annum. At present fuel prices, this is equivalent to raising the rent of each house by about 1s. 6d. per week. The committee therefore urged "immediate and determined joint action on the part of the Ministries of Health, Works, and Fuel and Power to make possible the fitting in all new houses, whether permanent or temporary, municipally or privately built, of new appliances of higher efficiency as recommended in the Government's Housing Manual, 1944." (FA) 1946


A new type of open grate was displayed which, it was claimed, would heat other rooms by the convective system and would be economical in the use of fuel. It was pointed out that more smoke was made by the kindling of a fire than at any other time; this would be obviated by the new type of grate, because by closing the damper the fire would burn all night, and by opening the damper it would relight in the morning. The opinion was expressed that it would be a big mistake to utilize waste heat from the power stations for heating flats. It is thought the time will come when the Minister of Fuel and Power will stipulate that certain types of fuel that create smoke must not be used. (FA) 1948


In the House of Commons the Minister of Health was asked if he would extend to all new houses the instruction that had been given to local authorities prohibiting the installation of fire grates and stoves of unsatisfactory types. He replied that he was consulting the Minister of Works as to the possibility of including a condition to this effect in licences issued for the erection of houses by private developers. (APB) 1952


In view of the difficulties experienced in running pulverized-fuel-fired boilers at low loads and removing the fly ash dry, a boiler of this type was fitted with an auxiliary traveling grate forming the lower closure of the combustion chamber. Methods of operating and regulating the boiler are described. The fly ash is bound onto the grate, and the flue gas ash content is not increased. Acceptance tests showed that the new boiler was as efficient as later slag-tap furnaces. (APB)

SMOKE CONSUMERS 1823


Ignition of the smoke with carburetted hydrogen or coal gas in some part of the boiler flue might not be impracticable. (MIR—Bib.) 1825


Small, globular, firebrick furnace connected with chimney and supplied with double bellows is proposed. It is worked by an engine, which is designed to constantly blow a stream of fire into the chimney; this will ignite the smoke as it passes up and cause it to rise in a flame. (MIR—Bib.) 1853


Describes smoke-consuming device, by which escaping gases are made to pass through red-hot tubes. (MIR—Bib.) 1884


Describes and illustrates many devices used with more or less success for stationary and locomotive work in England and America. (MIR—Bib.) 1887


Reviews devices for prevention and advocates use of the "air vacuum." (MIR—Bib.) 1888


Gases and smoke are deflected by a shield and made to pass through incandescent coal bed on way to flues. (MIR—Bib.) 1889


Describes German device for promoting the mixing of air with the gases of combustion. (MIR—Bib.)
AIR POLLUTION—A BIBLIOGRAPHY

1891

Secondary air supply is provided for burning escaping carbon monoxide and hydrocarbons in such a way that the chimney draft is not impaired. (MIR—Bib.)

Describes apparatus used for arresting fumes from fertilizer works. Claims that destruction of organic matters by passing over a fire “is a sheer impossibility. You can no more burn them by racing the gases impregnated with them over a fire than you can similarly burn smoke. To talk about burning smoke is, of course—practically speaking—to talk nonsense, and the only sensible talk relates to its prevention. Once produced, it, of necessity, goes to the chimney.” (MIR—Bib.)

1892

Simple apparatus in which smoke must pass considerable incandescent brick surface. (MIR—Bib.)

Perfect combustion with one-third block coal and two-thirds screenings. (MIR—Bib.)

1895

The qualities of a good smoke consumer are three-fold: (1) It must stop the black smoke that issues from the chimney when a boiler is newly fired; (2) it must cool the heated gases as they pass through the flues; and (3) it must do its work well, in spite of the stupidity and carelessness of boiler owners and attendants.
Imperfect combustion means not only the emission of a smoky cloud, which is offensive to the eye of the nuisance inspector, but also the loss of fuel and the more rapid choking of the flue with what should have been burned.
The forms of apparatus are those that admit air in front of the bridge, those that admit it from behind, and those that admit it at the bridge itself.
One well-meaning employer adopted a simple and effective method of smoke consumption 6 weeks after he was fined for the emission of smoke. The one who had recommended the smoke consumer visited him and found the apparatus useless through neglect of the smallest attention. The owner, all in good faith, said he had no idea that the arrangement would require to be kept in order. But experience had taught him, and thereafter there was no black smoke and no fumes.

1898

The air supply is automatically regulated. The fire bars are sloping and the quantity of air admitted to any part of the furnace is inversely proportional to the thickness of the layer of fuel at that point. (MIR—Bib.)

1899

A process patented in Germany and in the United States is described. It consists in distributing heated and slightly compressed air through hollow grate bars to the whole lower surface of the burning fuel. (MIR—Bib.)

1900

Invention is a method of controlling air supply. Air is admitted during firing and for a brief interval afterwards; a float valve operated by closing the fire door gradually closes the air passage also. (MIR—Bib.)

1903

2340. ENGINEER (LONDON). Wilskemt Smoke Consumer, Vol. 95, 1903, p. 450.
Additional apparatus is a small gas producer to supply gas to preheat firebrick arch. (MIR—Bib.)

Sheet-iron supply flues in close contact with the fire allow hot air to reach the fire in greater quantity. (MIR—Bib.)

1910

Gives information on furnace in which draft of hot air is driven down on fire, causing smoke to be completely consumed. (MIR—Bib.)

1912

Improvement is the addition of fire-clay tubes in furnace to retain heat for burning distilled gases. (MIR—Bib.)

1952

The operation of the “Finch Chimney-Thumb” unit as a link between the heating appliance and the flue to prevent smoking on windy days is discussed. (FA)

STEAM-JET DEVICES

1891

Discusses the steam-jet devices of Hutchinson, Clark, and Buchanan, with particular reference to locomotive operation. Concludes that, in general, the use of steam jets may show some gain in the way of smoke prevention but at the expense of fuel economy. (MIR—Bib.)

Discusses steam-jet device for use on locomotives. (MIR—Bib.)

1892

Classifies devices as smoke consuming and smoke preventing: favors the latter. Section is made to the use of direct steam jet, and a system has been devised by which the steam is used at a series of injector heads to induce a large flow of air, which enters with the steam at a low pressure. (MIR—Bib.)

Method consists in mixing smoke as it leaves the flue with small quantities of steam. (MIR—Bib.)

Claims successful smoke prevention and some saving in fuel by using automatically controlled steam jet for air injection. (MIR—Bib.)
Stein injector is used. Secondary air supply comes in contact with unconsumed gases in region of high temperature (MIR—Bib.)

Reviews conditions necessary to smokeless combustion. favors injecting steam through injector head with admission of air. (MIR—Bib.)

Steam jet, either flat or round, to force incoming air down upon ignited fuel is described. (MIR—Bib.)

1893

Tabulated results are unfavorable to the use of steam jets. These trials bring out one fact clearly—that the combustion was more complete in boiler A (furnace without steam jets) than in B (furnace equipped with steam jets); the result of better combustion was increased evaporation and decreased smoke. (MIR—Bib.)

1894

Uses steam jet and also a water spray to precipitate soot and dust. (MIR—Bib.)

Describes Sands’ apparatus for precipitating solid matter of smoke by introduction of steam into chimney. (MIR—Bib.)

1902

Apparatus is in operation at shops of the Chicago Bridge & Iron Works. Automatic steam-jet device introduces heated air from ash pit. (MIR—Bib.)

1903

Sketches accompany article to illustrate a blower in use in Worcester, Mass. Sketches are explained in detail.

1906

Information is requested on combustion phenomena in steam-jet furnaces. (MIR—Bib.)

Combustion with steam jets is discussed. (MIR—Bib.)

1907

Steam-jet furnace is described. Little steam is used in this device, which prevents smoke, increases the draft, helps to maintain the boiler pressure, and tends to prevent cinder. (MIR—Bib.)

Briefly describes tests with Ganz apparatus, which consists of steam jet with air supply and adjustable smoke damper. (MIR—Bib.)

1908

Discusses principles of smokeless combustion and application of steam jet as method of smoke prevention. (MIR—Bib.)

1909

Deals with examination of fuel (coal), giving rules for sampling, and for controlling combustion. Describes the “fumicide smoke consumer and fuel economizer,” which it is claimed was used for 2 years with excellent results. A box into which a steam jet forces air is placed in the furnace bridge, and the mixed steam and air are discharged into the furnace through a slit in back of box. To avoid disadvantages of the steam jet, later experiments have been made using a Sturtevant fan instead of the steam jet to induce the air blast. This modification is estimated to have resulted in a saving in working cost of the apparatus of 50 percent over the steam jet. (MIR—Bib.)

1910


Furnace is simply constructed, is adaptable to any type of boiler, and is claimed to be “an absolute smoke consumer.” Combustion is assisted by draft induced by steam jets. (MIR—Bib.)

Offers quantitative evidence as to effectiveness and operating cost of suitable steam-jet devices for boiler furnaces. (MIR—Bib.)

1911

Prevention of smoke depends on the use of hot blast, which is drawn into the combustion chamber by means of a steam jet. (MIR—Bib.)

1912

Reply to letter by Switzer. (MIR—Bib.)

Devoted mainly to an explanation of the drawings. Steam used “for creating a draft that will draw the smoke back into the furnace, where it will be burned up.” Steam also induces air to assist combustion. (MIR—Bib.)

Tests of Knoxville Railway & Light Co. and Knox-ville Cotton Mills are described in detail. Smoke consumers were installed under a contract guaranteeing to increase capacity of plant 10 percent, to reduce accumulation of soot on tubes 50 percent, and to effect an actual saving of 10 percent in fuel, in addition to reducing smoke. Introduction of automatically controlled steam jets reduced smoke production about 90 percent and greatly increased plant efficiency. (MIR—Bib.)

1916

2372. LEWIS, J. H. Developments in Smoke-Abatement Devices on Locomotives. Proc. Smoke Prev. Assoc. America, 11th Ann. Conv., 1916, pp. 167–190. Describes progress in the last 30 years in the use of the steam jet and methods of operation for eliminating dense locomotive smoke. Accompanying illustrations show that the railroads have done much work in supervising smoke in Chicago and that they have been foremost in the crusade against the smoke evil that has been waged all over the United States.

1928

2373. ARMOUR, JAMES W. Air. Jets As Aid to Smoke Abatement. Mech. Eng., 1928, p. 404. In a department of the magazine called the Conference Table the following question was asked: Is the introduction of the air jets over the fuel bed of an underfeed stoker beneficial in the reduction of smoke and will the use of such jets prove detrimental to efficiency?

1932

2374. STERN, A. C. Abating the Smoke Nuisance—Experiments With Steam-Air Jets to Boiler Furnaces. Mech. Eng., 1932, pp. 267–268. A general discussion dealing solely with the smoke nuisance caused by improperly designed hand-fired furnaces. A brief history of recent investigation along the lines of design of steam-air jets is given, such as conducted at the Case School of Applied Science.

1933

2375. ENGDAHL, R. B. Design and Application of Overfire Air Jets. Proc. Smoke Prev. Assoc. America, 37th Ann. Meet., 1943, pp. 82–88. Discusses the results of a laboratory study on steam and fan jets conducted by Battelle for Bituminous Coal Research, Inc. Many years of experience with jets of air directed over beds of burning solid fuel have justified the common acceptance of their effectiveness for smoke abatement, despite the very meager and even negative data available concerning them. In addition to the smoke abatement feature of overfire jets, their effectiveness in increasing the ratings of existing furnaces is widely recognized.

1946

2376. BENTON, E. D. Smoke Abatement: Steam-Air Jet. Laundry Age, vol. 26, 1946, pp. 63–74. Bituminous Coal Research, Inc., investigated factors that control the design and performance of steam-air jets of the type used in abating smoke by supplying overfire air. A drawing of the design finally adopted includes a muffler to silence the steam jet. Details are given about the selection and positioning of jets to suit different sizes of boiler installation. The original publication, Overfire Air Jets, by Engdahl and Holten, is mentioned, but no reference is given. (FA)

1947

2377. ENGDAHL, R. B. Application of Overfire Jets to Prevent Smoke in Stationary Plants. Bituminous Coal Research, Tech. Rept. 7, 1946, 23 pp. Instructions are given for installing jets in hand-fired and stoker-fired furnaces to force air into the furnace where it is needed and mix it with unburned gases. The use of jets solely to abate smoke is shown to be warranted only if no other method will do equally well, as the steam or power used is otherwise largely wasted. Automatic control of the jets by a photocell method, which gives a continuous record of the smoke density inside the stack, is recommended. (FA)

1947

2378. ENGDAHL, R. B., AND STAND, J. H. Test Effect of Overfire Air Jets on Boiler Efficiency. Report to Technical Advisory Board, Bituminous Coal Research, Inc.; abs., Ind. and Power, vol. 51, September 1946, pp. 66–69, 98. While the effectiveness of overfire air jets in abating smoke is well known, their acceptance, particularly for small units, has been limited, owing largely to fears as to their detrimental effect on boiler efficiency. Another factor limiting acceptance has been lack of knowledge as to costs of installation and operation. To obtain authoritative data on these questions, tests were sponsored by Bituminous Coal Research, Inc., as a part of its investigation of the fundamentals of overfire air applied to coal-burning furnaces. Two 24-hour tests—first using overfire air jets and then without air jets—were made on a horizontal, return tubular boiler. Heat balances were prepared for each test to determine the effect on boiler efficiency of the jets. Results indicate that the effect of the jets was not measurable or small enough to be accounted for by experimental errors. Overall operating costs, including power costs for the overfire jets, were virtually the same for the two tests. The major result of using the jets was a large reduction in smoke emitted by the boiler. (FA)

1947

2379. GROSA, B. Smoke Control at Bernheim, Southern Power Ind., vol. 64, 1946, pp. 58–60, 112; Chem. Abs., 1946, p. 5587. Satisfactory smoke elimination on a boiler subjected to widely varying loads was obtained by using steam-air jets; these assured complete mixing of the combustible gases and supplied enough air for complete combustion. However, steam requirements were about 2 percent of that generated by the boiler, and an excessive amount of steam was used at low and medium loads. This was remedied by controlling the steam used on the basis of the smoke in the breeching. A continuous smoke sample was taken from the breeching and passed through a cell provided with a controlled-voltage electric lamp focused on a thermopile, which actuated an a-c. potentiometer to give stepwise control of the steam to the jets. Steam consumption dropped 50 percent, and the instrument gave a permanent record of smoke output. Evolution of fly ash is minimized by furnace baffles and cyclone separators. (FA)

1947

2380. MAJOW, W. S. Have You Considered Overfire Jets for Smoke Abatement? Bituminous Coal Research, 1946, 8 pp. This pamphlet gives an outline of methods, equipment requirements, and data for determining sizes of overfire air jets for increasing secondary air with the objective of reducing smoke. (FA)

1947

2381. ENGDAHL, R. B., AND MAJOW, W. S. Application of Overfire Jets to Prevent Smoke From Stationary Plants. Bituminous Coal Research, 1947. Suitable methods for installing jets are given. The principles set forth apply to both hand-fired and stoker-fired furnaces. Instructions are given on how to choose a satisfactory size of tube for introducing the air, how far apart those tubes should be, where they should be placed in the furnace wall, and how to construct the jets for best results. (APB)

1947

2382. MAJOR, W. S. Overfire Jets for Smoke Abatement. Southern Power Ind., vol. 65, 1947, pp. 44–47, 121–122; Chem. Abs., 1947, p. 5276. Smoke is believed to be formed by the breakdown of the volatile matter in the coal to form C or soot particles when insufficient O is present; this process can occur above the fuel bed of hand-fired or stoker-fired
furnaces and can be prevented by turbulence and the introduction of additional air. Motor-driven blowers or steam jets can be used to entrain additional air as well as to produce turbulence. Proper design of the steam jets will minimize noise; these jets should not be permitted to impinge on furnace refractories or the fuel bed. The jets can be controlled manually by visual observation or photoelectric-cell warning devices. (FA) 1948


The effectiveness of modern overfire jets to reduce smoke from commercial and industrial furnaces is exemplified by representative installations. The overfire air may be supplied by motor-driven blowers or the air flow induced by steam jets. The examples cited have been selected to portray the versatility of jet application to the various types of furnaces and firing methods existing throughout the country. (FA)


The causes of smoke and the function of the jet are reviewed, and details of methods for using overfire jets are given. (FA)


Describes use of overfire steam jets. (FA)


Deals with overfire jets based on the work by Engdahl and others, of Bituminous Coal Research, Inc. Constructional details of the nozzles and the amount of overfire air required at different smoke densities are given. (FA)

1951

2357. BITUMINOUS COAL RESEARCH, INC. Application of Overfire Jets to Prevent Smoke From Stationary Plants. BCR Aid to Industry, ser. 500-300, 1951.

This is a revision of BCR Tech. Rept. 7, the results of which were reported in Trans. Am. Soc. Mech. Eng., October 1943 and March 1944. The engineering information is useful in the design, construction, and application of overfire jets to abate smoke from stationary plants. Sections of the report are devoted to design and construction of blower jets, steam-air jets, and plain steam jets; location, control, and care of jets; practical applications; a listing of manufacturers of jets, control, and smoke-alarm equipment. Tabulated and graphical data and many diagrams are included. (APB) 1952


Overfire jets prevent smoke before it forms by forcing air into the furnace to aid in the complete combustion of unburned carbon and gases. Benefits to be derived are discussed. (FA)

STOKERS

1877


Deals with development of mechanical stokers, describing many of the more important types at this date. (MIR-Bib.) 1889


Considers causes of smoke and claims that relief must be sought both in the mechanical stoker and the proper admission of air. (MIR-Bib.) 1890


Favors mechanical stokers for industrial furnaces, and use of coke or gas for domestic fires. (MIR-Bib.) 1892


It is claimed that although much may be done by careful hand firing, the remedy lies in the adoption of mechanical stokers, many of the existing types being successful when properly operated. (MIR-Bib.) 1897


Different members and visitors discussed various types of stokers and explained their operation.

There is no mystery in smoke prevention; it is only a question of intelligent engineering. Two requisites for preventing the formation of smoke are: To supply an adequate amount of free oxygen, and to have the gases subjected to a temperature at which carbon ignites. The construction and operation of a smokeless furnace was experienced also.

1898


The Davies automatic stoker was constructed to save fuel and increase the boiler capacity, but it has also proved to be a smoke consumer.

The operation of the stoker is described in detail.


With regard to smokeless operation, results were favorable to Murphy stoker. Various grades of fuel were tried, the best economy obtained being with the Hawley furnace using Pocahontas coal. With other fuels, the Murphy stoker proved superior. (MIR-Bib.)


The Acme stoker burns all grades of bituminous coal, practically without smoke, and comes well within the limits of the strictest smoke ordinance. It is durable, economical, efficient, and practical and embodies in its construction several novel features.


Discusses various devices and methods and quotes from a number of authorities on the subject. Gives tests of several mechanical stokers and deals at some length with the Lowe apparatus, said to be "the most simple, least costly, and most efficient smoke-consuming device yet invented." (MIR-Bib.)


After a series of careful experiments, it was decided that the following conditions were necessary for the proper and most economical combustion of coal:
(1) To ignite the coal and burn it without mixing it with fresh fuel, that is, that fresh fuel should not be commingled with the already partly consumed coal.
(2) To have the furnace so arranged that the combustion should be continuous and uniform; that is to say, when the furnace was in use the condition of the fire would be practically the same at any hour of any day of any week of the year.
(3) To make the work of firing as easy as possible, so that a minimum number of firemen would be employed and the whole operation of the furnace would be controlled by an intelligent man.

Coke's automatic stoker was designed to comply with these conditions. One of the most important features of the invention is the variable air supply, which is explained in detail.

In the Coke furnace the fresh fuel is ignited very slowly, owing to the variable air supply, and yet, after it is thoroughly ignited and travels toward center of furnace it has ample air to complete combustion, thus eliminating the smoke nuisance.


The stoker is described as being a simple and durable apparatus, which receives the fuel in bulk, feeds it mechanically at any desired rate to the furnace, and, after consuming all combustible matter contained in the fuel, deposits the ash and clinkers in the ashpit.

1899


General description of mechanical stokers. (MIR—Bib.)


Deals briefly with smoke problem and loss due to smoke. Favors underfeed' stoker with forced draft. (MIR—Bib.)

1900


Describes different types of stokers. (MIR—Bib.)


Some general discussion, followed by argument for mechanical stokers, describ'g various types. (MIR—Bib.)

2404. SCIENTIFIC AMERICAN. Smokeless Automatic Stoker. Stoker of Peerless Automatic Smokeless Stoker Co. is described. (MIR—Bib.)

1903


Working of Wilkinson automatic stoker. (MIR—Bib.)

1905


General treatment of the subject, considering bituminous coal only and not considering fuel economy. Believes that smoke production can be greatly lessened and considers mechanical stokers the best present means of accomplishing this result in medium-size or large plants. Shows that unless supported by public sentiment both mechanical devices and legal enactments will fail. (MIR—Bib.)


Comment on failure of stoker to eliminate smoke in locomotive firing. (MIR—Bib.)


Application of Wegener's mechanical stoker. (MIR—Bib.)

1907


Clear, simple description of the typical forms of smoke-preventing appliances in common use. Favors mechanical stokers, especially the chain-grate type. (MIR—Bib.)

2410. FOWLER, GEORGE L. Mechanical Stokers for Locomotives. Cassier's Mag., vol. 32, 1907, p. 70.

Describes the two types which have thus far met with any degree of success in operation. Looks with favor upon their introduction but admits that they do not effect any saving in fuel nor any diminution of smoke. (MIR—Bib.)

2411. HUTCHINS, GEORGE P. Stokers and Stoker Installations, Engineer (Chicago), vol. 44, 1907, pp. 820-821.

Fuel economy, rather than smoke suppression, is considered the end that should be sought. (MIR—Bib.)

1908


Deals with following types: Victor (formerly the Day-Kincard), Crosby, Hayden, and Strouse, and is largely compilation from "Railway and Locomotive Engineering." Mr. Wickhorst, in discussion, states that analyses of smoke gases have shown that by skillful hand firing combustion is almost perfect and this would argue in favor of a method of mechanical stoking which stimulates hand firing. (MIR—Bib.)


Gives results of investigation of a large Babcock & Wilcox boiler plant, equipped with Honeoye stokers. Tests were to determine cause of smoke and to suggest remedies. (MIR—Bib.)

1909


Considers mainly Strouse and Hayden stokers. States that a successful automatic stoker "should permit close attention to economic handling of fuel and reduction of black smoke." Discussion mentions smoke briefly. (MIR—Bib.)


Outlines principles of combustion and describes proper working of mechanical stokers, with table giving grate surface, air supply, and smoke formation. (MIR—Bib.)

1910


Touche's briefly on smoke prevention, reporting smokeless operation (except when fire was scraped or grates shaken) of underfeed stoker of the Pennsyl-
vania Lines West. Discusses several other types. (MIR—Bib.)

Claim is advanced that this design will "burn smokelessly the cheapest kinds of slack and smudge." (MIR—Bib.)

Brief description of boiler plant with sprinkling stokers. (MIR—Bib.)

Abstract of paper before Lancashire Branch of British Association of Textile Managers. Recommends coking type of stoker as more effective in preventing smoke than the sprinkling type. (MIR—Bib.)

1911

A brief comment is made on each type of stoker investigated. Discussion brings out evidence of a number of cases of successful operation without smoke. States that sufficient progress has been made with mechanical stokers "to warrant railroads installing a limited number upon large locomotives at least." (MIR—Bib.)

1912

Considerable attention is given to the Crawford locomotive stoker and its successful application to smokeless firing. (MIR—Bib.)

1913

Discusses merits of stokers and describes one type (Class "E" American stoker), presenting claims of smokelessness and high economy. (MIR—Bib.)

Favors mechanical stoker and carbon dioxide recorders, with careful attention to the latter as a guide to proper combustion. Looks with disfavor on smoke washing and on electrical precipitation of soot. (MIR—Bib.)

1916

Engineering progress in smoke abatement has shown clearly a method is available for solving each smoke problem. Causes of smoke, responsibility for smoke, and prevention of smoke are considered.
Specifications for and development of various types of stokers are described and illustrated. No one type of stoker is best suited to all applications. Local conditions of load, coal, draft, and boiler settings must be considered in selecting the type of stoker. Unless these engineering features are carefully analyzed and a decision based on this analysis, an unsatisfactory installation is sure to result.

1918

The advantages of using mechanical stokers are described.

1921

A summary is presented of the close relationship between underfeed stokers and smoke abatement. In this connection the history of the stoker is summarized briefly.

1923

The designs of furnaces must be such that they are conducive to proper operation without smoke.
The following points are covered: (1) For the abatement of smoke, large combustion space is necessary in the combination of mechanical stokers and steam boilers; (2) mechanical stoker should be designed so that they meet furnace dimensions of the modern steam boiler better; (3) any engineering that is done in connection with modern furnace design must be based on the performance possibilities of the modern, mechanical stoker and not based on stoker operation or possibilities of stokers that were installed 10 or 15 years ago.

1927

Two charts are presented, and a description is given of the results obtained in the first pass of a large modern unit operating with overfire air injection at the best pressure as determined experimentally. Such a combination gives a positive control over smoke.

1929

The operation of different types of mechanical stokers is described in connection with smoke abatement.

1939

To produce satisfactory operating results conditions that exist in the fire boxes of boilers should be in accordance with chemical laws required to produce complete combustion of the carbon and volatile matter contained in the coal.
The underfeed and overfeed types of mechanical stokers are described.

1937

A central heating plant in Washington, D. C., installed to serve the many monumental buildings, Federal and otherwise, is described. The many problems of architectural design, to conform to surroundings,
prevention of emission of smoke and fly ash, and economic considerations are discussed.

The type of coal-burning equipment chosen was underfed stoker. From the standpoint of smoke emission, the underfed stoker has an inherent fundamental advantage. It was considered that less ash would leave the boiler and that it would be simpler to obtain ash-free stack gases. An important step relating to the smoke and fly ash was the installation of unusually large stoppers for the loads to be carried.

An electrostatic-type precipitator was chosen for cleaning equipment. Various other measures for the satisfactory operation of the heating plant are mentioned.


With the cooperation of the coal industry, large consumers of coal have stepped ahead in its economical use. Quality of coal and quantity of smoke are no longer synonymous. It is now more a question of equipment, setting arrangements, and operating personnel.

Reference is made to the great advance that has been made in burning pulverized coal compared to the advance made on stokers. The home has not been neglected in the research and application of convenient automatic-firing equipment. Stokers can now be installed in any size home that has a furnace.


The use of the spreader stoker is discussed, and measures for preventing the emission of smoke and fly ash are suggested.


The amount of smoke produced by hand firing is compared with that from stoker-firing bituminous coal in a residence, and the significance of the widespread use of stokers to those who are concerned with preventing smoke is pointed out.

The residential underfed stoker probably will be a practical solution to the domestic smoke problem, because both high- and low-volatile coals can be almost completely burned. The coal and air are added simultaneously in the proper proportion, only when needed, and with intimate contact. In its present state of development the residential stoker is both economical and automatic in operation and produces so little smoke when properly installed and adjusted as to be entirely satisfactory to a meticulous householder.


The spreader-type stoker has been more commonly used during recent years because of its inherent ability to burn low-priced, high-ash, high-sulfur coal of relatively low ash fusion temperature. This advantage is offset by the tendency of such equipment to cause more trouble than other types of stokers as far as smoke and excessive fly ash are concerned. At least, this is true according to the records of the Department of Smoke Inspection and Abatement of Chicago. However, proper design and careful operation can overcome this disadvantage. Some of the fundamental requirements in their use are discussed.

Though the spreader type of solid-fuel feeding is not the complete answer to all the problems of the plant owner and operator, it has proved to be a practical and economical means of using lower cost fuels for steam generation.


The greatest aid in smoke prevention is properly designed furnaces, in which regulation of operation can be controlled mechanically to a large extent, especially where inefficient help is used in connection with firing the boilers.

The development of firing coal from the old hand-firing days to the so-called spreader-type stoker is outlined. Also, consideration is given to the adaptation of boiler walls to cope with the increased temperatures required for proper and complete distillation of the gases. Various heat-resisting materials have been tried, some of them with success. The adaptation of the waterwall to the powdered-coal furnace is discussed. With powdered-coal operation, it is possible to operate successfully without smoke, even though the wall area is quite cold, as the furnace volume in most instances is great, and the gases are distilled completely before passing off.


Gives the stoker rating adopted by the Stoker Manufacturers' Association on November 15, 1937. Gives standard formula, definitions, and charts 1, 2, and 3, with directions for using the charts.

Tables given have been prepared so that the stoker burning rate required under standard normal conditions can be read directly from the hourly load on the boiler or furnace. Directions for using the tables are given.


Suggestions and suggestions are given for the operation of underfed stokers supplied from 2,000 sq. ft. of direct radiation (or its equivalent) and up, usually designated as industrial or commercial in type. These instructions, however, are not intended to take the place of the individual stoker manufacturer's manual or card of operation, which should always be available in the boiler room.


The results of a field survey of boilers fired by underfeed stokers burning bituminous coal. The purpose of the survey was to collect data on the relation of the combustion volume and setting height to the smoke emission as at least a first step in the determination by experimental methods of the proper values.

The survey, which was conducted by Battelle Memorial Institute, was sponsored and financially supported by the Stoker Manufacturers Association, the Institute of Boiler and Radiation Manufacturers, the National Coal Association, and the Steel Heating Boiler Institute. The Smoke Prevention Association advised on the formulation of the program of investigation and followed its progress through two members, appointed by the President of the Association.


The mechanical development of the small underfeed stokers having a maximum coal-burning rate of approximately 60 pounds per hour is considered, and their development and application for residential heating is discussed. The method of feeding the coal is pre-
sented, with the principal parts, and the general method of assembling the conventional domestic underfeed stoker is illustrated. The résumé for the installation of stokers stresses the importance of making the installation with ample distance between the hearth and the heating surface and with ample combustion volume to obtain proper mixing, thus, preventing smoke.


A general exposition on smokeless operation at high ratings is presented. A diagram shows the air-flow control system, including the air meters on the boiler-control panel.

1941


The spreader stoker is described, and its advantages in firing are outlined.


The instructions and suggestions given apply to underfeed stokers supplying from 2,000 sq. ft. of radiation (or its equivalent) and up, usually designated as industrial or commercial type. These instructions are not intended to take the place of the industrial stoker manufacturer's manual or card of operation, which should always be available in the boiler room.

Charts and tables give the uniform stoker rating, adopted by the Stoker Manufacturers' Association, November 15, 1937.

1943


The merits of the spreader stoker are discussed. It has perhaps the widest range of application of any modern fuel-burning equipment. The first cost is modest and economically justified. It has a wide range of flexibility and is well suited to automatic control. However, as the smaller particles of ash leaving the furnace may be carried out of the stack in the plant vicinity, consideration must always be given to the use of a dust collector.


The chain-grate stoker and its operation are discussed. Given a reasonable amount of care the stoker will give years of satisfactory service, with very little maintenance, because it is a simple, rugged mechanism. Properly operated in a correctly designed furnace, there should be no smoke, and the fly ash carryover from the stack will be low enough not to be a nuisance.


The history of the development of the underfeed stoker is given, and the types and methods of installation and operation are discussed.

1944


Discusses the relation between the stoker or fuel-burning equipment manufacturer and the smoke-abatement engineer and particularly points out what must be done by the manufacturer to insure proper stoker installations from the standpoint of smoke abatement. The fundamental principles of a good smokeless stoker installation are correct size, proper furnace dimensions, suitable design, and careful operation. If they are followed, smokeless operation should be the result.


The advantages of the spreader stoker are described. However, when it is important that the stack of the installation be free of cinders and fly ash, it is desirable, with this type of stoker, to provide a method of precipitating his material. If ample combustion space is provided for the load to be carried and the fuel and air are carefully regulated, very little trouble will be encountered from excessive fly ash and cinders.

1945


The necessity for the correct operation of stokers—underfeed stokers are particularly considered—and adequate draft control for the reduction of smoke from the average heating boiler is discussed. (FA)

1946


The following factors of stoker installation are discussed, with reference to their effect on the smokeless operation of the equipment setting heights, furnace volume, ash storage, accessibility for cleaning fires, fly ash, and stoker windbox. (FA)

1947


A report is given on further observations on the operation of an iron fireman installed in a residence. Tests and observations were confined chiefly to operations with large lots of different coals, particulars of which are given, the chief defect of which was the high sulfur content. (APB)


Reasons are given for the failure of smoke and dust ordinances, and a plan for elimination of air pollution is outlined. The overfire stoker with cinder rejection, fly ash hoppers, the disposal of dust from mechanical fly ash collectors, the need for overfire air jets, and the advantages of smoke indicators with alarms are discussed. (APB)


Describes smoke control and maintenance of balance between steam required for process, mechanical, and electrical loads. New 35,000-pound-per-hour boiler is fired with chain-grate stoker burning washed screenings. (APB)

1948


The increased sale of anthracite stokers in America during 1948 is attributed to the enforcement of smoke regulations. (APB)

The problem presented by the stoker-fired boiler is discussed in detail. Until about 10 years ago, the spreader stoker was not used widely, pulverized coal was used primarily in large boiler units, and emission of solids was not a serious factor. Now, this picture has changed markedly as spreader firing has become common. Frequently, fly-ash emission is a serious problem, different from the older problem. It cannot even be measured by the same standards. Methods of handling the problem are presented.


Results of a survey by the Coal Producers Committee for Smoke Abatement are presented. It was found that only 33 percent of the plant equipment in Detroit was hand-fired, yet 65 percent was found smoking. The reason is said to be mainly improper installation or operation. (FA)


Operating methods to obtain optimum performance of underfeed stokers are described. (FA)


Examples are given of the position and installation of overfire jets in boilers equipped with various types of mechanical stokers. (FA)

1949


For use with a furnace and its stoker, a smoke eliminator comprising a feed pipe for conveying coal from the stoker to the furnace, a pipe section, flanges on the pipe section and feed pipe for removing the pipe section and including it as a part of the feed pipe, the pipe section having an aperture in its upper portion, a substantially annular vertical wall encompassing the aperture, a flange extending outwardly from the upper end of the wall, a perforated plate substantially the size of the aperture lying across the aperture, a second flange and core of the perforated plate lying upon the first flange, a third flange supporting substantially vertically from the inner portion of the second flange and integral therewith, means for securing the first and second flange together, an auxiliary flue pipe fitted snugly over the third vertical flange, and seated and welded to the second and third flanges. (APB)


It is stated in a review of the 84th Annual Report on Alkali, etc., Works (Great Britain) that it has become an accepted standard that stoker-fired boilers shall be furnished with efficient grit arrestors of the cyclone type and that electrostatic precipitation plant shall be provided for pulverized-fuel boilers. These provisions and the use of high chimneys are a safeguard against heavy deposition of grit and dust. (APB)


Specific reasons for smoke complaints from stoker-fired plants are discussed under the headings: (1) Improper design, (a) stoker design, (b) stoker-boiler setting design; (2) misapplication; (3) overlooking; (4) controls, (a) lack of guide instruments; (5) operating difficulties, (a) maintenance. Various recommendations are made. (APB)

1951


The author discusses the theoretical forces responsible for carryover from stoker fuel beds and gives some approximate equations for calculating the type and quantity of carryover that can be expected. A bibliography of seven references is appended. (FA)


The advantages of the underfeed stoker for burning bituminous coals that contain a very considerable quantity of volatile matter are discussed. Methods of using the system of firing is that it promotes complete combustion and freedom from smoke.

Although the principles of underfeed-stoker firing promote good combustion, from smoke is to some extent also dependent on other factors such as application and operation. It is, therefore, important that the stoker should be installed to the best advantage. Such features as combustion height and volume, that is, the height and volume of the combustion chamber, accessibility for removal of clinker and ash, adequate chimney draught, facilities for cleaning flues, protection for the mud ring in boilers, etc., should be given due consideration.


A plea for more stokers to attend technical schools. (APB)


In the planning and engineering of a new 200,000-pound-per-hour boiler for the Monsanto Chemical Co., St. Louis, the power engineers and designers were under great pressure from municipal authorities, as well as from the company, to produce a boiler installation to operate with minimum stack discharge, together with maximum reliability.

The traveling-grate spreader stoker was selected. This type of boiler requires less elaborate and expensive collecting equipment than a pulverized-coal-fired boiler. The boiler, stoker, and auxiliary equipment have operated satisfactorily. Careful planning and attention to details have resulted in a stack discharge well within the limits of 0.85 pound of fly ash per 1,000 pounds of flue gas required by the St. Louis ordinance.


It was not until 1883 that the manufacture of chain-grate stokers commenced as a commercial proposition, but not many were installed in industrial undertakings until the beginning of the century. Since then, the burning of inferior fuels has increased on water-tube boilers, both in power plants and large industrial plants, and up to date the chain-grate stoker has been widely accepted as being one of the most efficient means of handling the inferior fuels. It was therefore logical that such a machine would be developed to deal with a similar problem in shell boilers. Attention was focused on the need for an improved appliance for shell boilers during the war years when boilers of this type in many Royal Ordnance factories were of necessity derated to little over half their rated output because
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of the inability of existing types of firing equipment to burn these inferior fuels.

The general principle of the chain grate for shell boilers and its application to such boilers are discussed. Attainment of high thermal efficiency throughout the operating period of the boiler is no longer a matter of sustained pull with heavy firing tools. Brains can now replace brown, with obvious advantages both to the operation of the equipment and its maintenance in first-class condition.


Installing chain-grate stokers to high-pressure boilers at a colliery helped solve the problem of smoke abatement, which was linked with other problems, such as age of the boiler plants, low quality of fuel burned, and scarcity of skilled stokers.

1952


The basic idea of spreader-stoker firing dates back to 1857, although nothing was done patentwise until 1904. Dust collectors of some sort predate the development work on spreader stokers. The stoker manufacturer and the dust-collector manufacturer should get together on the requirements.

Characteristics of an ideal solution of the problem of obtaining satisfactory stokers and dust collectors are outlined. Many improvements have been made that make dust collectors much more adaptable to spreader-stoker firing, but the ideal has not yet been reached.


The arrangement of boiler-plant stokers, design of boilers, superheaters, economizers, air preheaters, mechanical draught, and flue-gas cleaning plant are discussed. (APB)


A summary of papers on smoke abatement in relation to chain-grate, coking, sprinkler, and underfeed stokers presented at the annual conference of the National Smoke Abatement Society brings out the principal relevant factors in each case. (APB)


Spreader stokers are a source of much unlawful industrial and commercial smoke. Data summarized by one municipal bureau of air-pollution prevention show the magnitude of the problem. According to the figures tabulated, spreader stokers comprised 6% of the approximately 600 mechanically fired units in industrial installations and caused 36% of the industrial violations for 1951.

Basic requirements for good spreader-stoker performance are outlined.


Forty-seven tests were made on a continuous ash-discharge spreader-stoker-fired boiler to determine means of reducing dust emission. In addition to burning rags, variables investigated were the amount of overdose air, the use of air, steam, and steam-air jets, the location of steam jets, the degree of reinjection used, and coal size. These tests showed that the use of overfire-jet turbulence decreased smoke density, carbon loss, and dust emission from the furnace. It was found that steam jets located low in the rear wall gave the lowest dust emission. Reinjection of all collected cinder decreased carbon loss to one fourth of its value without reinjection, but doubled the dust loading of the stack gases. The use of double-screened coal reduced dust emission appreciably.

This project was organized by Bituminous Coal Research, Inc., which obtained the participation of the American Engineering Co., Combustion Engineering-Superheater, Inc., Detroit Stoker Co., Hoffman Combustion Engineering Co., Iron Fireman Manufacturing Co., Riley Stoker Corp., and Westinghouse Electric Corp. The project was also supported by the General Motors Corp., which furnished the test site, special test facilities, and the coals used.


Manufacturers of steam-generating units are interested in the problem of air pollution and the work of the Air Pollution and Smoke Prevention Association. Selection of some of the auxiliary equipment, as well as the design of the furnace and boiler, is considered. Such subjects as presale engineering, furnace design, boiler design, preheated air, rishpit construction, ash removal, combustion control, forced and induced draft fan selection, and instrumentation are discussed. (9 refs. cited)

COLLECTION AND PRECIPITATION

1881


Brief note on experimental work and various papers of Aitken. (MIB—Bib.)

1883


Letter, discussing dust in air. Suggests clearing of smoky air by electric discharge.

1884


Draws no distinction between dust and smoke. Considers the settling of smoke and dust particles by electric discharge to be practicable. (MIB—Bib.)


Consideration of dust coatings surrounding solid bodies. Main causes of “dustfreeness” are considered to be due to molecular bombardment and gravitational settling. (MIB—Bib.)

1885


An experiment with an electric machine that causes fume to be deposited is described. Fume that is now carried forward through the longest flues and escapes from the chimney will be rendered so dense by the action of the electric discharge that it will not be carried so far by the draft and will rapidly deposit itself. Thus, works that now have considerable flues may look forward to obtaining a greatly increased yield of con-
densed fume. Others, who have not as yet considered it worthwhile to erect flues for partial condensation, will probably find it advantageous to do so, when by so simple a process they can obtain from a moderate length of flue a greater yield than could otherwise be expected from a very great length.

The speedy turning to technical utility of these experiments is but one more of the many instances demonstrating the unexpected and often surprising manner in which "pure science" of one day may be very valuable "applied science" of the next.


Describes process in which lead fumes were precipitated on a practical scale by electric discharge from a static machine. (MIR—Bib.)


Treats of dust of all kinds, including the constituent parts of smoke and fog, and considers its origin and behavior. Touches briefly on electrical precipitation of dust. (MIR—Bib.)

1886

2481. —. Electrical Deposition of Dust and Smoke, with Special Reference to the Collection of Metallic Fumes and to a Possible Purification of the Atmosphere. Jour. Soc. Chem. Ind., vol. 5, 1886, pp. 572-576. References are given to the literature on the subject. (MIR—Bib.)


1889


Brief description is given of experiments in electrification of smoke. (MIR—Bib.)

1890


A glass structure, with two iron plates, each with points. All parts of the surface but the points were covered with shellac varnish. On admitting a mass of smoke (from pitch oil), which was so thick that a bright light placed at the opposite side of the chamber was completely obscured, a current was passed between the plates by a small dynamo. The effect was instantaneous, and the chamber was cleared almost entirely of smoke. If a smoked glass is examined under the microscope, each particle will be seen to consist of amorphous carbon surrounded by an areola of oily matter. Rain does not precipitate it, on account of its water-proof covering, but air currents driving the particles together clear the fog off suddenly.

1892


Smoke, as it leaves the boiler, is mixed with a small quantity of steam generated in kitchen-range boilers. The mixed gas rises to an open chamber, the top of which is provided with pipes, placed in the direction of the prevailing wind, through which air passes and cools the gases. At the extreme top, just before entering the air, the gases are met with a spray of water from perforations in a conducting pipe. The result of this treatment is a washing of the smoke and complete removal of all soot, dust, and SO₂.

The amount of steam is small. At the Sloane gardens the expense is 10 gallons of water per hour. The apparatus treats the smoke from a large kitchen range burning 20 pounds of coal per hour. The draft is not sensibly impaired (?).

1998


Describes principles and apparatus of this process, separating finely divided solid particles from gases by application of electric charges. Process has been successfully used by Selby Smelting & Lead Co. (MIR—Bib.)

1909


Experiments using Hertzian waves and oxyhydrogen flames are described briefly. (MIR—Bib.)

1910


A series of experiments is described for recovering solid matter from smoke by precipitation. A sketch is included showing the elements of an experimental apparatus installed for dust recovery by the Calumet and Arizona smelter.


In late years the disposal of smeltery smoke has been of vital interest to agriculturists, foresters, and smelters, wherever farming, forestation, and smelting are carried on in the same locality. The problem has been earnestly attacked in some of the oldest smelting centers of the world, and yet it has been only partly solved. Some of the smelters of the United States have carried on much experimental work with more or less success. No plan, however, has been generally adopted, because each locality usually has a different problem.

One of the earliest plans for preventing contamination of the air by sulfur dioxide was to pass the sulfurous smoke through scrubbing towers through which water was passing, thus forming a solution of the gas in water. This method failed on account of the extreme difficulty of making a complete absorption and as it merely transferred the arena of toxic action from the air to the water. While working on this method in a physical testing laboratory at a copper smeltery near Salt Lake City, the idea occurred to the author that the sulfur fumes might be combined with the bases of the slag, the flue dust eliminated electrostatically, and the cost of the necessary plant and its profitable maintenance be more than covered by the savings from the dust and by the copper and other metals extracted from the slag.

The method is described in detail. The laboratory work demonstrated that smeltery smoke trouble could be eliminated with profit to the smelter.

1911


Considers development of process and application to sulfur fumes, especially from smelting plants, with some attention to precipitation of inorganic dust in general. (MIR—Bib.)
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Brief review of processes (MIR—Bib.)


The process of condensing dust and fumes by high-tension currents is reviewed briefly. This process is the invention of Dr. F. G. Cottrell, who has turned over his patent rights to the Research Corp. to be administered in the interest of the Smithsonian Institution. Only the various applications of the process are considered. Precipitation of smoke and cinders, smelting electrolytic slimes, condensation of acid mist, precipitation of smelter fumes, and purification of illuminating gas are discussed. A detailed explanation is given of the construction of the small apparatus prepared for demonstrating the Cottrell process.


Work done during the past 7 years on the electrostatic process for the precipitation of suspended particles from gases and fumes was presented at the New York Meeting of the American Institute of Mining Engineers, February 19-21, 1912.

The fundamental principle of Dr. Cottrell's process is the same as that of Sir Oliver Lodge's early scientific pioneer work on the same subject. Dr. Cottrell, however, succeeded in reducing the scientific idea to successful engineering practice on a large scale.

Application of the process to the Balakia Copper Smelter in Shasta County, Calif., and to a portland-cement plant at Riverside, Calif., is discussed.

The initial cost of installation at the smelter, which could treat 500,000 cu. ft. of gas a minute, was $135,000. The original cost of installation at the cement plant was $100,000. The cost of operation is very small. The smelter uses 120 kw., and the cement plant uses 50 kw.


Applies particularly to Cottrell process for electrical precipitation of suspended particles in smelter smoke.

(MIR—Bib.)


The control of the dust arising from rotary kilns in the manufacture of portland cement is continually becoming a more serious problem. This is partly the result of the enormous growth of the industry, which now demands factories of such magnitude that the large volume of gases leaving the stacks carry enormous quantities of dust into the atmosphere, but it is probably more directly attributable to the present trend of public opinion, which continually demands a more thorough control of fumes and smoke.

The installation of the Cottrell electric precipitation process at the Riverside portland-cement plant is described.

The possibility of recovering potash from the collected material is the subject of experimentation as the fieldspar used contains considerable potash, the greater part of which is caught in the electrical treater, which gives a dust containing considerable potash. This work is not advanced far enough to permit publication of definite figures.


Interest is indicated particularly in precipitation of coal smoke, and a brief account of experiments in this branch of the subject is included. (MIR—Bib.)


Cottrell process for removing suspended particles from gases by means of high-tension electric current is reviewed. Present (1913) applications are outlined, and difficulties encountered are discussed. (MIR—Bib.)


Brief review of processes. (MIR—Bib.)


Query regarding deposition of dust on walls beneath ungrounded wiring is attributed to difference of potential between charged wire and earth causing attraction of dust particles. (MIR—Bib.)


Electrical precipitation of dust from the kilns of the Riverside Portland Cement Co. at Crestmore, Calif., now makes possible the operation of the plant, which the farmers in the vicinity threatened to close permanently because of the damage to vegetation from the dust. The method is a modification of the Cottrell process for the precipitation of smelter fumes. The sale of the dust for fertilizer purposes pays the cost of operation, about 10 carloads being shipped weekly to the citrus-fruit growers.

1928


Discusses the feasibility of substituting hydrometallurgical processes in the treatment of flue dusts for the present method of returning the dusts to the furnaces for retreatment.

1929


The removal of the cinders and dust in contradistinction to the unconsumed tarry smoke is discussed under the following headings: (1) Electrical precipitation; (2) water elinder collector; (3) velocity collector; (4) baffle precipitator; (5) series cyclone collectors; (6) stationary turbocollector; (7) fan-blade deflector; (8) perforated casing fan; (9) thermix dust-eliminating fan.

1931


The enlarged power plant of the Harvard Medical School is described, with special reference to electrostatic precipitation of the flue dust. The new plant burns pulverized coal and includes a 1,000-kw. turbogenerator.
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As the plant is situated in the midst of groups of hospitals and schools, it is important that its operation shall be clean and as dustless as practicable. Therefore a good dust collector for cleaning the flue gases is essential.

1932


Findings are based on the original experimental data. The paper consists of two parts. Its purpose is to make available to others a miscellaneous assortment of practical information accumulated through constant use of precipitators over some 10 years.


A detailed description is given of 2 electrical precipitators so arranged as to serve 3 boilers. The factors responsible for the efficiency are a specially designed system of distributing ducts and division plates to insure uniform gas distribution over the entire area of the eliminator inlet. A recovery system of pulverized coal ash from flue gases has been in operation for about a year at the new electric generating station. Ten miles from the city of Michigan City, Indiana. According to the extended series of tests made by the builders of the precipitators, separation efficiencies range from 92 to 98 percent, depending upon the load.

1937


Experiments in flue-gas washing, with four tables of test results are discussed. The investigations that follow were undertaken during the power-station working conditions. A diagram shows a modified form of gas-washing plant.


Describes an installation using a wet type of flue-gas scrubber in connection with high-pressure boilers. Data respecting operating efficiencies at various ratings and materials of construction and disposal of waste water are supplied in detail. The system is particularly applicable to boiler practice.


A brief description is given of precipitators and cyclones, as well as a comparison of results to be expected.


Describes in detail a new system of fine gas purification, known as the Howden IC. It has been tested on an experimental scale for 2 years atBillingham.


The extraction of dust from its entraining gas may be accomplished in many ways. The methods more generally adopted may be grouped under the two headings, wet separation and dry separation. With either method, a surprising variety of types of apparatus is available, and it is often difficult to decide which type is the most suitable in any particular case. For this reason discussion has been confined to a description of theory and practical experimentation, which has resulted in the addition to the field of dry separation of a collector employing features of unique yet simple design, which in operation give collection efficiencies worthy of earnest consideration by engineers faced with the problem of dust extraction.

1936


The findings are based on original experimental data in addition to writing and experimental data of others. Conclusions reached are capable of practical application. Diagrams and illustrations descriptive of the conclusions are included.


Methods of removing acidity in stack gases are discussed.


A method developed in America where the force of gravity is used in place of electrostatic attraction for separating very fine particles held in suspension in a gas is described. The plant is known as the Lynch hot-gas granular filter.


At the new control heating station for public buildings at Washington, D.C., the electrical precipitators have been installed for final elimination of cinders, ash, and soot from the waste gases of stoker-fired boilers. Four principal factors had to be considered in designing the precipitators installed in this project. These were as follows: (1) United States Government specification required that whatever was installed should have a satisfactory operating history in a similar application; (2) because gases from stoker-fired boilers, especially at the lower ratings, carry relatively smaller amounts of suspended matter than do those from powdered-fuel firing, it was necessary to cling to a low absolute concentration of solids in the exit gases to meet the requirements or percentage of removal; (3) the suspended material in gases from stoker-fired boilers and smoke for black smoke, much of which behaves in a different way in an electrical precipitator, and the combination makes a somewhat more difficult precipitator problem than straight fly-ash elimination; (4) space limitations were such that for compact arrangement a vertical flow precipitator with the gases entering at the bottom was necessary.

These considerations led to the selection of a type of electrical precipitator, which, while comparatively new in the United States, had been installed for similar purposes at a number of European stations; all of these had satisfactory operation records. Nine photographs illustrate the design.


The principles and development of the Howden IC Plant for flue-gas cleaning as installed at the Fulham Power Station are described.

An isometric drawing of the operation of the non effluent gas-washing plant at Fulham is included.


This is the first in a series of authoritative articles concerning flue-dust collectors, dealing specifically...
with the determination of dust content, methods of flue-gas analysis, and standard sieves.


This is the second in a series of articles dealing with the design and operation of flue-dust collectors. It deals with various types of cinder traps, the method by which efficiency guarantees are arrived, and the principles utilized in the various cinder traps.


This is the fifth in a series of authoritative and detailed articles concerning flue-dust collectors. The article deals with the principles and functions of the turboseparator and the Selfert dust-extraction equipment. Operating efficiencies of the different type of dust collectors are discussed and compared as to practical value.


This is the sixth in a series of articles dealing with the design and operation of flue-dust collectors. It specifically describes the principles and functions of the Modair dust arrester and the diamond deduster. Corrosive properties contained in the flue gas present a complexity, and ways and means for minimizing losses due to this cause are outlined.


Deals with the efficiency of skimmer-type dust collector and shows how the recirculation of air through the apparatus adds to the efficiency thereof.

1937


A brief and general mention of the use of supersonic waves to remove soot from flue gases.


Attention has been called to the problem of sulfurous smelter gases throughout the world, and the processes that were being developed at Billingham to secure their economic utilization are discussed. The impetus to the solution of the problem was threefold: (a) the economic value of sulfur, amounting to more than 2 million tons per annum; (b) the necessity to abate the nuisance to health and vegetation caused by the escape of acid gases; and (c) the desire for national self-sufficiency in accordance with which many nations look to making themselves less dependent on imported sulfur.

None of these impulses has lost anything in weight or urgency. An increasing amount of attention has been given to the subject by research workers.


A detailed description is given of the working principles and functions of the spray form of scrubber used by the Boston Edison Co. to remove solid particles from the flue gas.


A dustless refuse-collecting machine recently brought out in England and being adopted by a number of cities is described.


A detailed description is given of the functions and operations of the Edgar Allen-Buell dust separator. The findings are based on actual experimental data as shown on the graph illustrating the relative efficiency of the separator under varying boiler loads and at different gas velocities. Statement is made of principles capable of practical application.


Reference is made to the development of air conditioning, which has drawn attention to the possibility of removing the smoke from the air used for ventilation so that the buildings can have clean air, even though smoke cannot be eliminated from the general city atmosphere.

A new type of electrostatic precipitator, recently developed, which is cheaper, smaller, and uses lower voltage than the apparatus formerly used for electric precipitation, is said to be suitable for almost all air conditioning applications. Many places exist in industry where low concentrations of fine dust must be removed.

To explain the features of this new precipitator, some of the general characteristics of atmospheric dust are described.


The information given is based on actual facts derived from experiments undertaken by the Fulham Power Co., London. The diagram shows a complete washer unit designed to treat flue gas. To keep the Fulham power plant from adding to London's smoke problem, permission for construction of the plant was granted only on condition that efficient flue-gas washing equipment would be installed. When completed, this plant was to consume 2,200 tons of coal per day, containing from 0.75 to 1.5 percent sulfur, an aggregate between 17 and 33 tons of sulfur a day; also, no waste products from washing were to be discharged into the Thames River. Therefore, a flue-gas-washing process, with a closed liquid circuit, had to be evolved.

In an experimental pilot plant especially designed for the purpose, a process, known as the Howden system of gas scrubbing, was developed. This system is capable of reducing the sulfur compounds in the flue gas to 0.02 gr. per cu. ft., and its dust content to 0.08 gr. per cu. ft. at atmospheric pressure to 32° F.


This is the seventh in a series of authoritative and descriptive papers on the design and operation of flue-dust collectors.

It deals specifically with the principles and functions of the Howden ICI gas washer, explaining its sulfur-removing and flue-gas-washing characteristics.


This is the eighth in a series dealing with flue-dust collectors. It explains and clarifies certain theories and practices of electrical precipitation, including a specific reference to the Sturtevant type of precipitator. The high-collecting efficiency by electrical precipitation is stressed.


This is the ninth in a series dealing with flue-dust collectors. The working principles of the micron centrifugal precipitator, the dry granular and cellular filter, and finally the bag filter are described.

This is the tenth in a consecutive series dealing with the various functions and principles of flue-dust collectors. The process by which the dust sludge is removed and washing liquid is explained, and further insight into the Lodge-Cottrell electrical precipitator is provided. Of particular interest are the photomicrographs of precipitated dust showing the different particle sizes caught by the Lodge-Cottrell filter.

1938


This covers, in a general way, the shortcomings of the Greenberg-Smith impinger, centrifugal separation, and thermal precipitation and describes a new electrostatic precipitator.


The findings are based on writing and experimental data. Conclusions are reached capable of practical application. The diagrams and illustration in the original paper are descriptive of the conclusions and should be consulted for a proper understanding.


Compares the three main systems used to remove dust from chimney gases. Each system has its advantages and disadvantages. The centrifugal separators are simple and low in price, but they will not separate the dust below 10μ in size.

1938


Insofar as atmospheric pollution is concerned, it can be eliminated only by correcting conditions at the source, which is the combustion chamber.

Various types of filters for cleaning air are discussed. Copy of a blank of the Department of Health of Pittsburgh, 100,000 were distributed, is appended to this paper. This blank was used in a community health survey by the Department of Public Health in cooperation with the Allegheny County Medical Society, the Municipal Health Council, the Metzler Institute, the Air Hygiene Foundation, the University of Pittsburgh Department of Industrial Hygiene, the Singer Memorial Research Laboratory, and the United States Bureau of Mines.

It is an effort toward control of the waste, discomfort, and illness caused by “smog.”


Describes installation of a new gas cleaning plant, incorporating the very latest in design and operation. A diagram shows the general layout of the boiler plant of the Derby Corp. Electricity Works and shows the arrangement of the precipitators. The plant consists of five powdered-coal-fired boilers.

2358. INDUSTRIAL POWER AND FUEL ECONOMIST. Eliminating Dust and Sulfur From Flue Gas. 1938, pp. 405-406.

New information regarding gas-washing equipment at Fulham Power.


The brick arch is an important factor in efficient heating, and its use in locomotive and industrial boilers results in fuel saving and smoke elimination. The arch brick baffles and delays smoke and gases so that they are retained in the fire box until they are completely burned.


The desirability of reducing the discharge of sulfur into the atmosphere is considered. Large boiler-plant operators have sponsored extensive experiments looking toward the development of processes for this purpose.


As a result of the work of the Harvard School of Public Health on electrical precipitators for collecting atmospheric particulate matter, the nonrectified alternating current was found to be superior to rectified current for precipitating dry, poorly conducting suspensions, such as most industrial dusts of hygienic significance. The essential parts of such precipitators are described.


The progress made in dust-collection equipment in Great Britain during the last 9 years is surveyed, and some exceptionally successful installations are described briefly.

A list of precipitators installed on power stations during a 9-year period is given, together with current consumption of 10 different units.


The efficiency of the Van Tongeren dust collector is discussed. The Van Tongeren dust collector was first introduced and installed in Germany in 1932. The collector was at once popular, the number in use rising to 500 by January 1938, because of its excellent operating results and economy.

1939


Discusses composition of fly ash, amount and sizing of fly-ash emissions, fly-ash reduction, methods of separating fly ash from products of combustion, and choice of fly-ash equipment.


Fly ash is defined as all solid particles emits to the atmosphere resulting from the combustion of fuel.

It is suggested that a general microscopic research on fly ash might reveal distinguishing characteristics relating samples to various fuel-burning conditions or fuels. Such knowledge would be very valuable to the abatement engineer.

The sizing or particle size leaving the stack is of great importance from a nuisance standpoint. The abatement engineer's problem of fly-ash reduction includes consideration of methods of separating fly ash from the products of combustion before they reach the top of the stack and the amount of ash to be expected.

A simple scheme for determining fly-ash emission that could be included in a practical ordinance is needed. Methods for determining the amount of fly ash are discussed. Included in the paper are 55 figures showing various methods of separating fly ash from the products of combustion.
The difficulty is pointed out in deciding the amount or sizing of fly ash from a stack that creates a nuisance, how to legislate against it, and how to determine the amount and sizing of the fly ash.

1940


Apparatus is described in which solid or liquid particles are separated from gases by projecting them with high velocity against the surface of a liquid. (FA)


The use of vertical cylindrical separators for examining industrial dust in the air according to the size of the dust particles and their velocity was studied. The results on velocity of the air current for separating the various dust fractions, dependability of the method, limits of analysis, electrical charging and abrasion of the particles, and their adhesion to the walls of the separator indicated that the method is unsatisfactory. (CA) (JIIHT)

1941


The fly-ash problem of the smoke-abatement engineer starts with the necessity of his knowing what fly ash really is, what plants create it, and how much is being created. In this connection fly ash may be defined as all solid atmosphere resulting from the combustion of fuel.

The problem of fly-ash reduction includes consideration of methods of separating fly ash from the products of combustion before they reach the top of the stack and the amount of ash to be expected. Thirteen figures show various methods of separating fly ash from the products of combustion.

The problem of choice of fly-ash-separating equipment involves separating efficiency, draft losses, space requirements, and costs. Each problem is a highly individual study. Most of the knowledge of the actual separating efficiency of the various types of equipment, as expressed in figures, is that supplied by those developing the equipment. The range of efficiency based on total ash content of all size particles appears to be from 15 or 20 percent up into the nineties. Ration figures can also be based on the efficiency in removing chosen size particles.


Sources of air contamination are surveyed: solids, liquids, gases, bacteria. Methods of removal of air contamination are discussed; dry and wet filter methods are considered; and dust collectors and air filter methods are reviewed. Particular attention is devoted to discussing the application of ozonizers for the removal of bad odors, practical operational details being treated. The installation of ozonizers in all industries causing offensive odors is recommended. The treatment of H₂S and CO₂ is considered. The application of ozonizers to food storage is discussed in detail. Experiment shows that ozone prevents tainting of one food by the odor from another in the same storage. The many advantages of installing ozonizers in breweries is pointed out. The great importance of air purity in this industry is considered. It is concluded that air conditioning is an extravagance in many cases, air purification being superior. (JIIHT)

1950


Describes experimental work conducted at smelter of Consolidated Mining & Smelting Co. of Canada, Ltd., Trail, British Columbia, to obtain uniform and rich sulfur dioxide effluent gas from Dwight-Lloyd sintering machines. Presents results of plant tests and laboratory work conducted with stationary equipment.


The equilibrium between large and small ions in a gas, the large ions being produced on smoke particles and the small ions by means of Po or X-rays, has been investigated. When equilibrium is established between the two types in the presence of neutral particles, a definite fraction of the neutral particles is converted into large ions of each sign. This fraction depends on the size of the particles, but if large, it is independent of the concentration of small ions. If the concentration of large negative ions is about twice greater than the number of large positive ones, however large the particles may be, and the number of large ions is independent of the presence in the gas of particles previously charged. An application of the theory of Langevin gives the coefficient of formation of large ions. The different results obtained by various workers on large ions in the atmosphere can be explained on the basis of the theory. There appears to be a favored radius for ions produced on smoke particles or in the atmosphere. (FA)


The particles in a given volume of fog are collected in a layer of oil by suitable application of an electric field and are then counted and measured visually with the aid of a low-power microscope. The droplet diameter (2 to 10μ) in a fog increases on being kept. (FA)


A series of impinger samples collected at granite plants was examined simultaneously by (1) the standard lightfield count, (2) Spencer hemocytometer cell count, (3) darkfield count, and (4) photoelectric measurement of light intercepted vertically by a column of the liquid. Attempts were made to correlate the four series of results. In three series, each with 18 to 35 samples, a fair agreement was found between the lightfield and hemocytometer counts when the latter was divided by 1.18, 1.28, and 1.27 respectively. No such agreement was found between the darkfield and lightfield counts, even when elaborate corrections for particle-size variations were made with the assistance of the method of light intercepted. In comparing the light-interception method with the lightfield method, there were indications that definite relations existed, but the attempt to state them mathematically for practical use did not succeed.

Size-distribution determination and the examination of fractions after settling gave some assistance, but not enough work has been done to establish a good correlation. It is concluded that the hemocytometer and light-interception methods can be used, with judgment under limited tests to reduce naturally the time required for routine investigations. Suggestions are made for a possible method for the development of
rapid photoelectric determinations to give approximate estimates of count and size of particles, to explain discrepancies encountered with present methods, and to extend the scope of use to which the more rapid methods may be put. Much research must be expended on that point before it is established. Descriptions of the method and full experimental data are included. (JHT)

1943

2554. AKTIEBOLAGET SVENSKA FLAKTFABRIKEN. [Arrangement for Settling Dust or Other Solid Impurities From Gas or Vapor by Treatment With Liquid.] (Application Patent 72,581, 1942.)

The liquid is introduced into the upper part of the separator, together with the gas or vapor; the liquid fails freely through the apparatus, while the gas or vapor is drawn in by rotary fans, one above the other at the center of the apparatus. When rotary the fans divide the liquid finely, eject it, and mix it intimately with the gas or vapor. After each ejection, the matter in question is collected at the middle of the apparatus by collecting funnels placed above the fans. (APB)


Examines the dedusting efficiency of cyclones and electrofilters for cleaning fuel gas and describes methods of selecting equipment suited to the conditions of a particular case. (FA)


The foggy air is drawn through a light metal cylinder (earthed) in which a wire is suspended axially on insulating supports, being charged to a high negative potential. Thus, the fog particles are precipitated on the cylinder walls, and the increase in weight of the cylinder gives the water content. Suitable dimensions of the apparatus are given. (APB)

1944


The Cottrell process of electrostatic precipitation of fly ash from burning pulverized coal is discussed.


(A) Brief information is given regarding the following types of dust collectors: (1) Settling chamber, where the dust is deposited by gravity; (2) cyclone collector, which separates the dust by centrifugal action (simple cyclones are used for shavings, sawdust, but high-efficiency cyclones are necessary for fine ash and kilns); (3) viscos collection, where dust is trapped by the viscous surface is a filter; (4) wet collectors, such as washers and scrubbers; (5) cloth collectors, whose uses and limitations depend on many factors, the operation involving envelopes, bags, or screens of cloth that will withstand the temperature (cotton only suitable below 150°F, wool up to 250°F, above which asbestos is essential) and permit a filter cale of dust to build up on the cloth and be periodically removed. In designing such a system, the ratio of air flow to cloth must be carefully considered, otherwise maintenance cost is high. For flake-type dusts, a ratio of 1 cu. ft. air per sq. ft. cloth is necessary; for amorphous powders, such as carbon black, the ratio should not exceed 2:1; for foundry or clay dust, it should not exceed 3:1.

(B) Electrostatic precipitators remove dust particles less than 1 μ in diameter, but owing to ozone production, the high-voltage Cottrell precipitator is not suitable for ventilation systems, although it is successful in smelting plants and cement mills. The recently designed electric air cleaner, which generates the minimum of ozone, makes it possible to remove airborne dirt, soot, and smoke from offices, stores, banks, ceramic plants, and industrial process buildings. Mention is made of the possible development of electric air cleaning for home use, particularly in houses with forced-air heating. Trial installations in houses around Pittsburgh have proved successful, especially from the health aspect and where there are sufferers from hay fever. (FA)


The discussion is confined to the centrifugal dust collector or precipitator and boiler fly ash.

Although all agree that the quantity of discharged solids should be greatly reduced, there is too little understanding as to what constitutes a reasonable solution, what is involved in reaching this solution, and the difficulties in proving certain mythical performance predictions.


The problem of fly-ash collection at the boiler has received much attention in the past 15 years, resulting in satisfactory cooperation between manufacturers of coal-burning equipment and boilers at new installations, and in producing combined units to insure clean boiler settings.

Stoker applications to existing boiler installations make it incumbent upon stoker manufacturers in many instances to recommend, design, and frequently install entrapment means within the settings and fly-ash conveying systems, for reinjecting carryover into the furnace to meet normal requirements of various existing smoke and fly-ash abatement laws.

The discussion and statements are limited to several designs of equipment to collect fly ash at the boiler and their application.


It is maintained that the Morizett law (1932) limiting the admissible dust content of smoke to 2 gr. per m² for old plants and to 1.5 gr. per m² for new plants, with a maximum total of 500 and 300 kg. per hour, respectively, is too rigid, since even a relatively small quantity of dust can cause grave inconvenience. Three methods of cleaning are discussed: (1) Centrifugal separators; (2) electrofilters; and (3) wet filters, which not only recover dust but also harmful gaseous constituents (CO, SO₂, etc.). Centrifugal separators and sieves do not remove dust of size less than 30 to 40 μ. Electrofilters remove dust even as fine as 1.5 μ. Wet filters are less popular than the more simply operated dry ones. (FA)


Three different units used to give the gas a whirling movement are described. A slender design, having greatest height but small diameter, proved to be most efficient. Maximum sedimentation, with minimum pressure drop, is accomplished. (APB)


A device for the periodical rapping of the electrode surfaces to remove deposits. (FA)
1945


A detailed description is given of the dust collectors fitted to the tops of six inch-diameter cupolas at a Michigan foundry. The collector carries water-spraying equipment through which the cupola gases emerge. (FA)


An attempt has been made to test the efficiency of electrostatic precipitation when applied to cooling tower vapor, and satisfactory results have been obtained. High-voltage electrical-discharge equipment was inserted in the upper part of the tower, and 40 kV. d-c. voltage was applied, which would condense the vapor within the shell of the tower. (FA)


The scrubber is designed for mounting on top of stacks, such as cupola stacks, to prevent sparks from escaping into the atmosphere and to wash the flue gases of foreign particles and noxious vapors. The wash liquid is water that flows over the top of the tapered deflector and falls from its edges across the gas outlet. (FA)


The removal of dust particles from air entering air-conditioned carriages effects economy in interior maintenance and enhances passenger comfort. Precipitation electrostatic air filters have been adapted for carriages in the United States, which remove 99 percent of the finest dust particles. The air entering the precipitator is purified by way of a mechanical filter, which eliminates the large particles of dirt, and then passes through an electrostatic field set up between an ionizing wire and earthed rods. The small dust particles thus energized are deposited by electrical attraction on charged collector plates. Means are provided to clean the plates. (FA)


The basic theory and principles of operation of an electrostatic precipitation are described. The optimum operating voltages, the nature of the electrode surface, and the inflow of air through the precipitator are considered, and their effects upon dust precipitation are discussed. An equation for the efficiency of an electrostatic precipitator is given, and a nomograph is reproduced, which simplifies the calculation of the dimensions of a cylindrical precipitator. (FA)


The resistance coefficient of a body moving in a fluid depends on the Reynolds number \( R \), the ratio of the velocity of the body to the velocity of sound, or Mach number, and the parameter \( pL/U^2 \), where \( L \) denotes a characteristic length, \( U \) the body's speed of translation, and \( p \) the acceleration of gravity, which can be better replaced by \( A \), the local fluid acceleration regardless of the force producing it. Evaluation of the acceleration of the air flowing about spheres puts this parameter in the form \( LR \). It is shown that by plotting the pressure coefficient \( p/2U^2 \) against the parameter \( LR \) the confusion in the interpretation of the sphere test reports is removed by placing the low- and high-pressure coefficient groups in two distinct regions separated by the critical value of \( LR \), whereas the low- and high coefficient groups are connected by a rather sharply defined transition curve, occupying a very narrow range of \( LR \) values, which evidently indicates the separation of the flow at high speed due to the inertia of the fluid. (FA)


A review of the various types of dust-particle-size analysis, including a number of liquid sedimentation methods in which measurement is by pressure, hydrometer, pipette, photometer, and sedimentation balance. Other methods are turbidimetric, permeability, and gas adsorption. For general control of dust conditions, a liquid sedimentation method is recommended, supplemented by a microscopic or screen analysis where required. (FA)


Describes procedure using MSA aluminum precipitator tubes as a shipping container. Plastic caps for the tubes are provided, which protect the sample during shipment should any precipitate fall off the tube wall. The data confirm Barnes' observation that the tube weights can be held within \( \pm 0.15 \) mg. No mention is made of weighing the central electrode, which we have found to retain as much as 25 percent of the total fumes, with concentrations occurring during welding. Bubbles also found at as high as 17 percent on silicon dust. As described, this technic apparently neglects the material caught on the central electrode. (JHHT)


The application of electrostatic principles to air filtration is discussed briefly, and a recent self-cleaning model is considered. The filter has an efficiency of 85 to 90 percent in removing atmospheric smoke, as compared with less than 25 percent for mechanical filters. Electrostatic air filtration has also proved effective in removing oil vapors and welding fumes from the air. (FA)


Smoke emitted by coal fires is discussed, and dust removal by centrifugal means is described. Reference is made to the effect of the density of grits on the amount and condition of the dust and to the use of various dust-removal devices. Dust removal by electrostatic means is considered. The discussion covers the influence of speed distribution in electric filters, the nature of the electrodes and of electric devices to secure efficiency, the influence of temperature and of water and CO content upon the working of the filter, and the effect of particle diameter. (FA)

1946


The equipment required, the various types of precipitators for specific applications, and the different factors that enter into the design of a modern Cottrell installation are discussed. The equipment varies influencing the rate of precipitation or efficiency of removal are also presented with particular reference to gas velocity, time of treatment, current flow, and surface conductivity of the suspended particles. A number of the more recent developments of a technical and engineering nature are given, and the various applica-
tions of the Cottrell equipment in the chemical field are discussed, with specific mention of the application in the phosphorus, pulp and paper, carbon-black, and petroleum industries. (FA)


An arrangement for removing the dust from the flue gases in ducts such as chimneys, comprising a concentrator for obtaining a concentrated dust film along the inside of the duct wall, a slit or slits in the duct wall for withdrawing part of the gas, and a collector for cleaning the flue gas, and a fan or the like for reintjecting the cleaned gas back into the duct at such a position relative to the above mentioned slit or slits as will produce the required rotation of the flue gases in the duct. (FA)


The Koppers-Elex electrostatic precipitator, now becoming available to American industry, removes boiler fly ash, tar, acid mists, soda ash, fluorides, catalysts, dust, and other byproducts from plant discharge gases and is especially interesting to industries in municipalities that have control ordinances. (APB)


The design of tube- or bag-type and screen-type collectors is discussed. (APB)


Apparatus for treating dust-laden gases comprising a primary dust separator having an air inlet, an air outlet, a supplemental air passage having a venturi therein to the throat of which the dust outlet is connected, whereby dust is aspirated from the outlet by the venturi and reduced pressure is created in the lower portion of the primary separator, a secondary dust separator receiving the supplemental air and the dust from the primary separator, means for mixing air from the air outlet of the secondary dust separator with air passing through the air inlet to the primary dust separator, and means for reducing the humidity and temperature of the supplemental air mixed with the dust-laden air passing to the primary separator. (FA)


The dispersion of dust in an air stream passing through a cyclone, decreases the pressure drop across the cyclone. Using a 9-inch cyclone of the multicicloane vane type, the fractional decrease in the pressure drop, for a given rate of flow, has been found to vary as the square root of the dust concentration. To calculate the volume of air passing through a cyclone from pressure-drop values, measured when dust loadings are relatively high, a correction factor must be applied to the pressure drop values. Collection efficiencies of a cyclone have been determined for concentrations of the test dust, which vary from 0.5 to 100 grains per cubic foot. The effect of dust concentration upon collection efficiency has been shown to be small but not to be neglected for accurate work. (FA)


A dust-containing multiple unit for removing dust from gas by centrifugal or vertical action, each of the units employing apparatus comprising an outer tubular member into which the dust-laden gas is caused to flow and an inner tubular member serving as the outlet for the cleaned gas. The outer member is provided at the end opposite the gas inlet with tangentially directed discharge openings and with a central opening for the return of the gas into the main cleaned gas in the inner tubular member. (FA)


A cyclone separator comprising, in combination, a conical separator casing having a centrally arranged air discharge in its upper end, means including an inlet conduit for introducing dust-laden air into the upper portion of the casing tangentially to the inner surface thereof to form a downwardly moving dust-precipitating outer spiral of air and an upwardly moving inner concentric spiral of air being discharged, and means comprising a vertically disposed interceptor conduit arranged concentric to the separator casing and extending upwardly through the casing and said discharge to the exterior of the casing and provided at its lower end with an inverted hood of greater cross-sectional area than said conduit and positioned with its open lower end portion in close relation to the restricted lower end portion of the separator conduit communicating at its other end with the inlet end of the separator, a fan interposed in said interceptor conduit whereby dust suspended in said inner spiral of air at the lower portion of the separator is intercepted by said hood and directed through said interceptor conduit to the inlet conduit of the separator. (FA)


Tables summarize the characteristics of various air-cleaning methods while a curve shows the size distribution of outdoor and industrial dusts. (FA)


The design of trap, cyclone, and volute or spiral types of centrifugal dust collectors is discussed. (APB)


Particulars of the design and construction of the "Rheu Mech" automatic textile sleeve dust collector are given. In these dust collectors the textile filter tubes suspended from a common tube plate over each compartment of the assembly. The lower end of each tube is closed and has attached to it a weight which maintains the correct tension. Dust-laden air enters the bottom of the tube compartment and passes round the sides of the tubes through which it is drawn and filtered. The filter tubes are cleaned by the usual method of periodically reversing the air flow through the tubes in successive chambers throughout the plant, and simultaneously agitating these tubes to loosen the dust clinging to the surface. (APB)


Recently No. 3 boiler at Peterborough power station, fired by pulverized coal, was fitted with a duplex Aerotec dust-collector installation. The primary collector contains 204 6-inch diameter cyclones and the secondary collector 420 of 2-inch diameter. A recent test showed that the overall efficiency of the collector was 91.33 percent. Dust entering the cyclone was 99 percent through a 40 I. M. M. sieve (under 31.75 μ); that passing the collector was 100 percent under 69 μ and 78.3 percent under 20 μ. Thus the efficiency of collection of dust over 20 μ is high. (FA)


The principle of the cyclone separator is discussed. It is inherent in the centrifugal principle that small separators give higher collecting efficiency than large
ones. For large gas quantities it is necessary to employ a great number of small cyclones working in parallel for high efficiency. After having solved the problem of breaking up individual cyclones in parallel into the sieve, the I. G. Farbenindustrie undertook large-scale tests in its power station at Bitterfeld. The tests were so promising that I. G. Farben agreed to replacement of the experimental sieve after 12 months' use by an improved one, again consisting of 300 cells. The improvements incorporated are now accepted in modern design. These improvements are described. The centrifugal type of extractor can also be used with advantage to clean the intake air of all types of automotive engines. The Viennese type of cylindrical extractor chamber found extensive use and is now fully accepted. The exhaust gases can be used for evaporating the contents of the internal dust-collecting space. Such plant once installed requires no further attention. (FA)


Electronic air filtration is based on the principle that an electrically charged dust particle will be attracted to a charged electrode of opposite polarity and repelled by one of like polarity. As the efficiency of an electronic air filter is not influenced by the weight of mass of the dust particles from the air stream, it has extended high-efficiency dust removal into the lower range of fractional micron sizes. The elements of an electronic air filter are described; important factors in its maintenance are noted, and its applications and advantages discussed. (FA)


An apparatus is described and illustrated whereby a gas stream aspirates a suitable oil from a reservoir before passing through eight conical, perforated metal diaphragms which collect the oil droplets and present a large surface of contact without impeding the air flow. The collected oil flows back to the reservoir where solids separate out in a quiet zone before the oil is again aspirated through the system. (APR)


A method was devised to determine whether the number of condenser conduction nuclei can become a bioclastic factor, insofar as water droplets which condense on them precipitate atmospheric impurities, which might act toxically or as allergens. A vessel of 8-liter capacity contained NH3 and water vapor, either with filtered air or with air containing a large number of nuclei from smoke. Only in the latter case did a sudden 25-percent decrease of pressure give a visible condensation fog. With this fog, NH3 was precipitated, collected in a Petri dish with fluid paraffin, and was then colorimetrically estimated. With 500 nuclei per cc, 0.04 mg., and with 200,000 nuclei per cc (cigarette smoke), 0.16 mg. of NH3 were precipitated. (CA)


The data obtained indicate decided lack of uniformity in dust-counting techniques between different laboratories, and further thought should be given to clarification and standardization among laboratories. The following may be taken as a starting point for further work on clarification and standardization of dust-counting procedures:

(1) The nature of the dust being collected should determine the collecting medium to be used rather than using one collecting medium for all types of dust. If the dust is soluble in water or tends to flocculate, an alcohol should be used for collection. On the other hand, if the dust is soluble in alcohol, then water, or water plus a suitable wetting agent, should be used.

(2) Much has been said as to the relative merits of light-field versus dark-field illumination. However, as we are not so much concerned with making an absolute measurement of the dust in the air, but instead are interested in a reproducible index of the density of the air, and as light-field illumination is used by most of the laboratories, it would seem wise to continue to use light-field illumination for all standard dust counting.

(3) The length of time allowed to elapse between collection and counting of the sample should be kept at an absolute minimum. If it is necessary for the sample to be kept for several days before counting, which might be the case if the dust samples are sent in to one central laboratory, then for fibrosis-producing dusts as an example, the sample should be collected in undiluted alcohol (either ethyl, n-propyl, or isopropyl) rather than water.

(4) The conventional Sedgewick-Rafter cell or other cells 1 mm. deep is still the choice of the majority of laboratories. Some laboratories report excellent correlation of counts between cells 1 mm. deep and shallow cells such as hemocytometer, whereas others report that for certain dusts it is difficult to obtain good correlation. In changing from a cell 1 mm. deep to one 1½ mm. deep it is advisable to make check counts using both type cells until comparable results are obtained.

(5) The blank count should be kept at a very low figure, preferably under six countable particles per ½ mm.² counting area in the cell. This insures that reasonable care has been exercised in preparing and subsequently handling the collecting mediums and sampling equipment.

(6) The concentration of dust per counting area should be at least four or five times the "blank" count and preferably not more than 100 particles per ½ mm.² counting area. It has been the experience of various investigators that, if the count much exceeds 100 particles per ½ mm.² counting area, counting becomes very time-consuming and quite often inaccurate. In cases where the concentration exceeds 100 particles per ½ mm.², it has been found preferable to further dilute the sample and prepare new cells for counting.

(7) Counting in one plane on the floor of the cell chamber is to be preferred to counting throughout the depth of the cell. Experiences of various investigators have indicated that it is more difficult for different persons to obtain comparable results when counting throughout the depth of the cell, than when counting in one plane only.

(8) Much has been said as to the length of time the sample should be allowed to settle in the cell before counting is begun. Some laboratories use a fixed settling time, whereas others allow the sample to settle until, in their estimation, all the particles have settled. Consequently we find settling times for cells 1 mm. deep varying from 5 minutes to 16 hours. Inasmuch as we are more interested in a method of counting that will give reproducible results rather than attempting to count all of the particles, it would appear practicable to employ a fixed settling time for all dusts. A settling time of exactly 30 minutes for cells 1 mm. deep and 5 minutes for cells ⅔ mm. deep would seem most desirable, in that this allows a large percentage of the easily counted particles to settle to the bottom of the cell, and still this settling time is short enough to allow a reasonable number of samples to be counted during the day. (FA)

An air cleaner comprising a vertical shaft, a plurality of electrical precipitators forming at least a portion of the vertical walls of the shaft, means closing one end of the shaft, vertical partition members dividing the shaft into a plurality of vertical conduits each having at least one of the electrical precipitators in an external wall thereof, and means in each of the vertical conduits at the end thereof opposite the closed end for closing the conduit independently of the other of the conduits. (FA)


A critical survey of various types of dust collectors is presented. Those covered are: settling chambers, centrifugals with and without impellers, washers, filters, and electrostatic precipitators. (FA)


A review of the mechanical devices used for the final disposal of solid materials delivered by the dust-collection system of an industrial plant. Both dry- and wet-disposal methods are discussed. (FA)


Electrostatic precipitation methods are indicated where very high efficiencies are required in the removal of dust or where particles in atmospheres are too small to be dealt with mechanically. Electrical precipitation depends upon the intensity of the electric field, the volume of gas or air, the temperature of the gas, the degree of initial ionization, and the type of corona discharge employed. Distribution factors are considered and the principle of the method of operation for dust removal is discussed. Two types of ozone producers for use on a large commercial scale, both depending for the production of ozone on the discharge of high-voltage electricity between stationary electrodes, are described. The "Kleenair" electrically operated conditioning unit is referred to. (APB)


An illustrated description is given of the "Sirocco" dust-collecting apparatus and its combination with the Pleanum and exhaust systems of ventilation in the removal of dust in raising, flax scutching, and similar operations. (APB)


The theory of particle-size distribution in airborne mists and dusts is presented. (FA)


In a dust collector having plurality of substantially vertical cyclone tubes having alined upper ends enclosed in a substantially horizontal apertured wall, having a plurality of smaller gas-outlet tubes having alined upper ends extending from above the cyclone tubes, having spin vanes between the cyclone and outlet tubes, and having a substantially horizontal gas duct above the tubes, which has an inlet at one end and an outlet at the other end. The combination of a pair of spaced, substantially horizontal, apertured walls encloses the upper ends of the outlet tubes and extends from one end of the collector to the opposite end thereof. Partitions extend upward from the sides of the walls of the duct to the lower portion of the duct; similar triangular partitions extend upward from the partitions, and contact the upper wall of the duct between the inlet and outlet with their apexes. The triangular partitions have sides sloping from the apexes to the lower portions of the inlet and outlet and other partitions extend from the upper wall at the points of contact of the apexes to the lower portions of the inlet and outlet and between the triangular partitions and contact the sloping sides thereof. The partitions and the pair of walls form substantially constant-volume, gas-inlet passages from the inlet into the vanes and form substantially constant-volume, gas-outlet passages from the outlet passages from the outlet tubes to the outlet. (FA)


A dust-collector unit comprising a pair of substantially similar circular hoops, a third circular hoop having a larger diameter than the hoops, a rotary shaft, means spacing the hoops of the pair and supporting some from, and concentric with, the shaft and supporting the third hoop between the hoops of the pair and concentric with same, and a sheet of filter cloth stretched over the hoops. (FA)


In a dust collector and separator, an upright casing, a bottom diffusing cone and an inverted cone of less diameter than the casing spaced above the first cone, forming a centrifugal separating chamber, a tangential inlet for dust-laden air to the chamber, a hollow filter located above the second cone to receive the air passing upwardly around the periphery of this cone, and an inverted cone above the filter forming a diffusing chamber with its inlet connected with the outlet of the filter and discharging laterally into the diffusing chamber. (FA)

2600. LOPHEIM, T. B. Separating Dust or the Like From Air or Gases. British Patent 582,480, 1946.

Claim 1: A device for separating dust or like materials from air or gases, comprising conical drumlike sections of a casing divided by blades on a central rotating shaft into compartments through which the air or gas passes longitudinally, characterized by the feature that the cross-sectional area of each compartment increases with the distance from the axis of rotation, so that heavier particles are removed by centrifugal force, while lighter particles are deposited in the compartments near the axis. (FA)


Claim 1: Apparatus for extracting solid materials from gases comprising a cylindrical casing (with a tangentially arranged gas inlet) which tapers or decreases in diameter to an outlet for the solids at its lower end, a hollow frustum of a cone supported by the tapering portion of the casing so as to contact the bottom of the frustum and the portion of the casing where it is supported, the upper end of the frustum being at a lower level and of less diameter than the gas-outlet pipe, centrally disposed in the top of the casing, and a series of radiating fins arranged between the frustum and the gas-outlet pipe to eliminate whirl from the gases passing to the outlet along the frustum. (FA)


Relates to separators of the kind consisting essentially of a casing having a lower conical dust-collecting part and an upper cylindrical part which surrounds a central cylindrical outlet duct arranged to discharge at its upper end through an end wall of the casing, a tangentially directed inlet delivering the dust-laden
gaseous stream into the annular space in the upper casing part at a relatively high velocity. An adjustable partition is provided to subdivide the lower dust-collecting chamber into two concentric spaces and is so disposed in relation to the outlet duct that the inner space receives substantially only the inner gas layer, containing little or no dust, that travels down the outer surface of the outlet duct. (APR)


A self-contained electrostatic precipitator, comprising a circular base, a tube mounted in a vertical position centrally on the base and having an air entrance nipple at its upper end for receiving an air conduit. An electrically driven blower means is mounted in the tube for drawing air therethrough. An ionizing zone includes an electrically conductive ionizing-zone cylinder, and an ionizing wire arranged axially therein mounted below the blower means in the tube, causing ionization of air passing therethrough. An air detector in the base directs air passing through the tube upward therearound. A plurality of electrically conductive cylindrical dust-precipitator plates is arranged in spaced relation concentrically around the tube in the path of the air deflected upwardly. A power pack is mounted in the base for converting low-voltage electrical energy to high-voltage for electrically charging the dust-precipitator plates and ionizing-zone cylinder and ionizing wire. (FA)


Apparatus for separating dust and the like from a gaseous or vaporous medium having. In combination, a vertically extending chamber, a plurality of vertically spaced downwardly inclined baffle means, each extending across the chamber and having an opening adjacent to the vertical axis of the chamber, and a plurality of fans one arranged below each of the baffle means in closely adjacent relation thereeto. The fans have their inlets adjacent to the openings of the baffle means and radially extending fan blades rotate about the axis, as well as means for entering the dust-containing medium into the chamber above the uppermost of the baffle means for successive flow over the upper sides of the latter to the openings. The fans act to suck the medium into the chamber and fling the dust-laden liquid outward from adjacent the axis toward the peripheral walls of the chamber to form the liquid and mix it with the medium and force the mixture toward the bottom of the chamber. The baffle means act to direct the outwardly flung mixture from one fan to the inlet of the fan immediately below it. Further baffle means are provided below the lowermost fan for directing the mixture outwardly flung by that fan toward the center of the chamber to promote whirling of the mixture, whereby to promote separation of the dust-free gaseous constituent from the dust-containing liquid constituent of the mixture. There are also means for discharging the dust-free constituent from the chamber, and means for returning a portion of at least the dust-containing liquid constituent to the upper portion of the chamber for constituting at least part of the washing liquid for the gaseous medium entering the chamber. (FA)


An open-cycle gas turbine burning pulverized coal is to be developed by the Locomotive Development Com- mission of the Luminous Coal Research. A specific problem is to remove fly ash, especially particles of larger diameter, from the hot gas coming from the combustion zone between the main burner tube and the annular air inlet. Excess air is to be used for cooling the gas to a safe level. A gas-cleaning device must be obtained capable of operating at a temperature of about 1,400° F, and at a pressure in the range of 40 to 100 lb. per sq. in. The device must operate effectively with a low static-pressure loss. The institute is to study the characteristics of small-diameter cyclones, particularly the 2- and 3-inch-diameter Aerotec models, testing with loadings of 0.15 to 3.0 grams per ft.² of fly ash, temperatures up to 1,400° F., and pressures up to 100 lb. per in.². A second phase is study of the ablading action of fly ash suspended in air at the pressures, temperatures, and loadings above and at velocities to be expected in a turbine on targets of various metals. The effect of particle size will receive special attention. (APB)


The dust-laden gas is passed through a bank of cyclone tubes 6 inches in diameter, and means are provided whereby its direction of motion is suddenly reversed, causing the dust to be deposited. (APB)


An apparatus for separating suspended particles from air or other gaseous media in which the particles are first subjected to centrifugal separation to remove the larger part of suspended particles, and to segregate the remaining particles in a limited volume of the purified gaseous medium from which they may be separated by suitable means. (FA)


Clam 1: A process for separating soot and fly ashes of flue plants, characterized in that the gases on their way from the furnaces to the heat-utilizing plant are passed tangentially into an inertia separator of the cyclone type so that centrifugal action is set up at the suspended solid. The solid is then thrown by peripheral wall and move spirally to its outlet while the clean gases, their velocity greatly reduced, escape into the low-pressure region along the cyclone axis and depart through a central tube or cylinder projecting into the cyclone at the opposite end. (FA)


Apparatus for separating suspended material from gas at high pressure is described. (FA)


Suction by a stream of compressed air is used instead of that by electric fan. (FA)


Methods of determination of dust in the air by sedimentation, filtration, washing, adhesion, electric precipitation, thermal precipitation, and optical properties are described briefly, but none are considered to give very exact results, either quantitatively or qualitatively. (APB)
AIR POLLUTION--A BIBLIOGRAPHY


Discussion of principles of the cyclone separator; influence of the depression within the separating chamber; formulas for calculating the depression; applications of the vertical motion on precipitation; calculation of the capacity of a cyclone. (APB)


In a liquid-bath air cleaner, there is a casing having separated inlet and outlet openings and a liquid sump in the lower part thereof in proximity to the path of air traveling from the inlet to the outlet. The casing is reduced in size in the vicinity of the liquid sump to provide an inner shoulder, a removable filter arrangement in the casing, releasable means supporting the filter arrangement in operative position, and other supporting members attached to the lower part of the filter arrangements and projecting over the inner shoulder to support the filter arrangement still in an operative position if the arrangement becomes unintentionally loosened. (FA)


Claim 1: In an air cleaner, a casing having a closed top and a liquid sump at the bottom, a filter holding partition in said casing and spaced from said casing to define a downwardly loading air path therebetween. A closed top on said partition is shaped to form a chamber beneath the closed top of said casing and outside said partition equivalent in capacity to said liquid sump. Said casing has an inlet opening at one side below said chamber, said chamber receiving and retaining liquid from said sump if said chamber is inverted while in use. (APB)


A size-distribution function is suggested which gives the proportion of the particles with a given settling rate (which is itself proportional to the square of the diameter) as the product of a polynomial of the settling rate and an exponential function of this rate. This distribution has the important property of retaining its form during sedimentation of the dust from a uniform suspension of the particles. This function gives results lying between the logarithmic probability function and the Rosin-Rammler function. Lappé has found in practice that the distributions of dust lie between the logarithmic probability and Rosin-Rammler functions, (FA)


The removal of CO from atmospheric air by aqueous caustic solutions was studied for three packed-tower arrangements. Data were reported for absorption of CO at atmospheric pressure, by sodium hydroxide solutions in a 12-inch i. d. tower packed to a height of 7.8 and 16 ft. with 3/4-inch Raschig rings and a 12-inch i. d. tower packed for 10 feet with 1-inch Bert saddles and for the 10-foot tower operating at elevated pressures as well as for atmospheric pressure scrubbing with aqueous potassium hydroxide solutions. The data, evaluated in terms of overall absorption coefficients, can be expressed by equations of the form,

$$\log K_\text{CO} = -0.20 \log L - K$$

The results are presented graphically and indicate that $K_\text{CO}$ increases with the gas rate as the 0.35 power for flow rates up to 500 lb. per hr. per sq. ft.; the rate of increase in $K_\text{CO}$ diminishes above this flow rate, being only as the 0.15 power of gas rate at flow values in the neighborhood of 1,000 lb. per hr. per sq. ft. Studies made using an aqueous potassium hydroxide solution gave values of $K_\text{CO}$ 20 to 30 percent greater than those for an aqueous sodium hydroxide solution of equal normality at the same operating conditions. The effect of pressure was determined up to a total pressure of 100 lb. per sq. in. gauge. $K_\text{CO}$ was found to decrease as the 0.5 power of absolute tower pressure. The effect on $K_\text{CO}$ of conversion of the scrubbing solution to carbonate and the effect of temperature are estimated. (APB)


In recovery of finely divided solids from gases in processes such as fluid cracking, the efficiency of recovery by electrostatic precipitators is greatly increased by the addition of small quantities of ammonia or ammonia-containing compounds, which also improves the smoothness of running of the precipitators. (FA)


The tubes comprising the Aerotec dust collectors, of which four sizes may be obtained, are of the same design and operate on the same principle as those in the Prat-Daniel tubular collectors, the difference being one of size. A general-assembly diagram is given illustrating the way in which batteries of tubes are mounted and the course of air or gas in its passage through the dust collector. A graph shows the size of dust particles that will be thrown down in the new collector plotted against the efficiency in each size range. Mild-steel tubes are standard, but they can also be supplied galvanized, or made of stainless steel or plastic material. (FA)


Test methods and performance standards for unit dust collectors are suggested based upon examination of 28 makes of units and upon performance of 18 collectors. Specifications of the ideal unit dust collector are presented. (FA)


A uniform-velocity distribution is sometimes desirable in channels or ducts, for example, in electrostatic precipitators, and may be secured by a reduction in the flow cross section or by incorporation of a homogeneous resistance across the flow area. A quantitative mathematical analysis of the two methods is presented, and equations are provided for use in connection with design problems. (FA)


This invention relates to centrifugal fans combined with dust collectors and relates more particularly to centrifugal fans having double, involute inlets, with built-in dust collectors. Centrifugal fans having double, involute inlets are commonly used as induced-draft fans, in steam power plants, for example. (APB)


Gives theory of electronic air filtration and a description of the modern plate-type electronic air filter. (FA)
CONTROL OF AIR POLLUTION

Cleaner for air of the centrifugal type, including a suitably curved passage with a dust trap arranged to divert from the main flow dust concentrated by centrifugal action on the outside of the curve. A thin layer of air is withdrawn from the inside of the curve where cleaning action is greatest and any excess air is ejected. (FA)

A fly-ash removal system having in combination a furnace, including primary and secondary combustion chambers, a fly-ash collecting pit disposed below the secondary combustion chamber, and means for shielding the pit from the radiant heat of the secondary combustion chamber for the purpose of preventing fusing of fly ash deposited within the pit. (FA)

The efficiency of aerosol filters is greatly increased by impregnating the filter material with polyurethane. The effect of electrostatic charging. (FA)

An air-cleaning device comprising, in a cylindrical casing an intake chamber, a spray chamber, and a separating chamber. The intake chamber has a tangential inlet to establish a rotary motion, and the spray chamber has jets for projecting a spray and baffles and deflectors. A series of upwardly extending passageways delivers the rotating column of air into the spray chamber, and another series receives the rotating column from the spray chamber and delivers it smoothly into the separating chamber. (FA)

A historical review and practical discussion of improvements. (FA)

The construction and operation of a small dust collector for removing solids from smoke are described. (FA)

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The gas-fired Westinghouse air-conditioning system in a house in Pennsylvania fitted with electric dust precipitators and sterilizing lamps is described. The precipitators are so built that dust, smoke, and soot carried into the system must pass through a high-voltage electrical field where they receive a positive charge and then pass through a secondary field of opposite polarity causing them to precipitate or drop on plates where they may be flushed down the drain with water. The voltage required for the operation of an electric dust precipitator may be obtained by stepping up commonly available voltages with a transformer. The sterilizing lamps are installed in the return air duct on the leaving side of the dust precipitators. The life of each lamp is approximately 6 months. Their electrical requirements are 110 volts, 60 cycles alternating current and suitable control equipment to turn them on whenever the blower operates. The advantages of sterilizing lamps in conjunction with dust control are mentioned. (FA)

In the calculation of gas-cleaning apparatus, such as cyclones or dust precipitators, it is generally assumed that the flow inside the apparatus is laminar, whereas actually it is turbulent. The flow being turbulent, the sedimentation processes differ vastly from the assumed ones. Two occurrences caused by the turbulent flow are that some particles fall short of the sedimentation surface and some are carried off the surface after they have settled out. Actual calculations of sedimentation in a turbulent flow are difficult but close results can be obtained by basing the calculations on statistical means of turbulent scattering of dust particles toward the retaining surfaces. (APB)

Theory and types of electrostatic precipitators are reviewed. The relationship is established between the amount of precipitation, number of corona edges, and the coefficient of precipitation of the dust on one corona edge. The problem of intensification of dust separation is examined in relation to recent applications. Types of current sources are described. (APB)

A review of available information of the various ways in which pulverized fuel ash might be utilized indicates that, while it is not very suitable as a raw material for cement manufacture, its use in blended cement as a pozzolanic material and as an addition to concrete mixtures may be of value in some circumstances. Other possible uses of the future are in the manufacture of tiles and cellular concretes and as a filter for bituminous materials. (FA)


Mathematical expressions based on the work of O. G. Sutton are given for the variation of the concentration of SO, at the ground in the neighborhood of a chimney, in terms of the coal consumption expressed as tons per hour. The distribution of dust deposit on the earth's surface in the neighborhood of the chimney emitting them is discussed, and recommendations are made on the siting of power stations with a view to minimizing any nuisance which might be caused by the emission of fumes. (APB)

Claim 5: Apparatus for washing gases to remove particles of foreign matter. (APB)
AIR POLLUTION—A BIBLIOGRAPHY


The commercial electrostatic precipitator has been modified and improved as follows: (1) The operating voltage has been increased by the development of an oil immersed coil which will provide voltages up to 15,000; (2) the so-called dependency of the electrical system has been secured; (3) rapid and easy changing of the vibrator points has been achieved by the development of a new, totally enclosed vibrator unit; (4) a flexible head has been developed which will insure greater sampling flexibility; (5) a nanometer made of plastic material has been designed to obtain greater accuracy in measuring flow rates; and (6) a description is given of a simplified voltometer which will indicate the performance of the instrument with ease and dependability. (APB)


One great difficulty lies in the treatment of gases and fumes from the distillation and cracking of petroleum. The effectiveness of these gases is due to the presence of small quantities of hydrogen sulfide and mercaptans. It is usual to collect and pass them through a scrubber to remove a light hydrocarbon, after which they are burned under the boilers or stills. The sulfur compounds are thus converted to sulfur dioxide which in low concentration does not normally give rise to nuisance and is definitely less objectionable than H₂S. The light gases arising from sour oils during storage also have an offensive odor and care must be taken to minimize their escape. (APB)


Details are given of the physical factors that govern the sedimentation rate of particles roughly below 100 μ, that fall slower than 10 cm. per sec. Methods of calculating the velocities of isolated spherical solid particles are summarized, and a table shows the error introduced by assuming Stokes’ law under various circumstances. The behavior of liquid drops and of air bubbles is described and an account given of the corrections needed in the other aggregations. The effects of molecular and turbulent diffusion upon sedimentation are considered. A typical airborne dust is shown to contain particles whose density is increased with increasing particle size owing to the loose nature of the larger aggregates. The effect of sedimentation velocity on the sampling of airborne particles is studied. The trajectories of particles that are sucked toward an orifice while they are falling are worked out; and it is shown that the number sampled in a given time is independent of their rate of fall, so that a true sample results. This applies in calm air, when the orifice is small enough, and if the inertia of the particles is negligible. (APB)


The apparatus consists of a number of cast-iron elements mounted vertically in staggered formation on an inclined cast-iron plate. A water tank is mounted on the top of the apparatus, and a collecting hopper is bolted to the lower edge of the baseplate, the outlets being immersed in an effluent trough. Water is pumped to the top tank and then passed down over the elements through the baseplate into the collecting hoppers. The dust particles impinge on the water film, flowing down the elements with sufficient force to overcome the surface tension, and are carried away by the water.

The staggered arrangement of the elements insures that the dust particles which pass between those in the first row impinge on those in the second row, and so on throughout the apparatus. The efficiency of the arrester with nine rows is 92.5 percent and tends to rise with increase in dust concentration. (APB)


The increasing number of pulverized-fuel-fired boiler plant installations has called for intensified efforts to improve still further the efficiency of flue-dust collectors. The various methods of dust removal are considered with special reference to cyclone-type collectors. (FA)


Claim 1. A centrifugal dust separator in which rotary means are adapted to whirl a stream of particle laden gas, wherein the separator is adapted not only to separate particles from the gas stream, but also to concentrate particles remaining in the gas stream in a part of the gas stream and is provided with means for withdrawing from the gas stream a current of gas containing a concentration of particles. (FA)


After processes for recovering byproducts from gas-washing plants, using as the alkali, appear to be practicable. One of these, the production of cement and sulfuric acid, has been operated commercially in a different connection and proved to be sound. Cost of this process has been tested and shown to be capable of charging the expensive gas washing by the non-effluent system from a charge of 35.4d. per ton of coal burned in the boilers to a credit of 5.4d. per ton. The second process, the decomposition of the washer solids by ammonium carbonate, to produce ammonium sulfate for sale and calcium carbonate to return to the scrubbing system, appears to be sound, provided complete oxidation of sulfite to sulfate can be achieved either before or after the reaction with ammonium carbonate. Alternatively, the product can be treated with sulfuric acid to remove unwanted ammonium sulfite. This process is also based upon known commercial processes and appears to be worth developing further. Further processes for the recovery of byproducts from flue-gas washing plants using as the alkali ammonium or ammonium carbonate as the scrubbing medium. The products from the most promising of these processes are ammonium sulfate and sulfur, both of which have a ready sale. It is probable that the capital and running costs for this system of gas washing will be lower than those for any other system of gas washing, with recovery of byproducts. (FA)


Claim 1: A separator with a housing into which the medium to be treated is admitted through an inlet tube extending into the housing, including a cup-shaped member positioned over the inner end of the tube through which the medium can enter the cup-shaped member at the inner end, and baffles in the form of annular disks positioned in the ring space between the tube and the wall of the cup-shaped member, one series of alternate baffle disks having ears extending in the opposite directions at its outer edge and the other series having ears extending in the opposite direction at its inner edge to maintain the disks in spaced relation within the cup-shaped member, the spaces between the ears at the outer and inner edges respectively, presenting passages which permit the medium to flow over the baffles in zigzag paths toward the bottom of
the housing, the assembly of baffles being retained in the cup-shaped members, by an in-turned flange at the open end thereof. (APB)


Describes the design, construction, and operation of a sensitive photoelectric instrument developed primarily for measuring smoke penetrations through efficient gas mask filters. It can be calibrated to measure smoke concentrations and is applicable to a wide range of uses in colloidal chemistry and photometry. (APB)


A detailed description of a 60-kv. (max.) precipitator for 70,000 m³ per 24 hr. gas flow, consuming 0.8 kw. per 1,000 m³ and with a cleaning efficiency of 99.8±9.2 percent. The corona discharge around the wire electrodes ionizes the gas; the tar drops become negatively charged and are collected on plate cylinders. (FA)


The apparatus (described and illustrated) consists of a settling tower into which the dust is introduced. A dust magazine (charge tube) from which almost instantaneous and complete discharge is obtained by an air blast, and an exposure chamber at the base of the settling tower by which slides or leaves are serially exposed to the dust cloud. Consistent results have been obtained. (FA)


An illustrated account is given of an air filter (American Air Filter Co., Inc.) that employs assemblies of positively and negatively ionized plates for the electronic deposition of dust. (GA)


The apparatus is of the suction type and automatic in operation. Textile sleeves, which form the filtering medium, are cleared of dust by mechanical shaking at regular intervals. The sleeves are cleaned by periodic reversal of the direction of air flow. Intercepted dust is collected in a screw conveyor and is discharged through a star wheel which forms an air lock. (APB)


In a dust-collector suitable for installation in a boiler pass with gas temperature up to 1,000° C, louvers in wedgelike formation change the direction of gas flow by 90°. The particles in the gas, unable to follow the sudden change of direction, are projected through an opening in the boiler wall into cyclones while the gas returns to the gas pass of the boilers. The louvers can be water-cooled if desired. (APB)


Measurements were made in a model cyclone tower on the rate of absorption of sulfur dioxide by alkaline solutions and on humidification of the gas. The effect of entrance design, gas and liquor velocities, and nozzle spacing are correlated in such a manner that the performance of large towers can be predicted. The towers provide high rates of absorption as well as good efficiency for the removal of finely divided dust particles. They may be operated over a wide range of conditions and loading of the cyclonic or centrifugal separators. (APB)


An attempt is made to evaluate the factors involved in the design of the cyclonic or centrifugal separators. The requirements of the separator and the influence of gas throughput on absolute cyclone size are outlined. The proportions effect of inlet velocity, gas temperature, gas humidity, and dust concentration on the performance of the separator, and the design of the cyclone are discussed. Reference is made to applications not within the province of mining. (APB)


The characteristics and concentrations of dust commonly found in flue gases of pulverized-fuel furnaces are discussed and the main methods of removal described. Cyclones have hitherto been used extensively on stoker installations while electrostatic precipitators have been more popular on pulverized-fuel installations. Recent advances in the design of cyclones have, however, encouraged the use of this type of dust-removal equipment. The advantages of the cyclones are their simplicity, compactness, and freedom from ill effects from gas overloading under chemical reactions with coal constituents. Spray washers alone fail to meet the requirements of pulverized-fuel installations as their dust-removal efficiency is only 70 to 80 percent. Some degree of film washing is therefore necessary. The paper includes comparative data on the cost of dust extractors and methods for testing them. (APB)


An electrical precipitation method for analyzing smokes according to particle size has been investigated. A thin stream of smoke particles moving under laminar conditions in a wind tunnel of onedimensional section is electrically charged in a small region. The charged particles are then precipitated by the uniform field existing between the upper plate and the grounded lower plate of the wind tunnel as a long track along the lower plate. The size-frequency distributions of the particles precipitated at various points on the lower plate were determined from measurements on enlargements of electron microscope photographs. Agreement between theory and experiment is fair, but the range of sizes of the particles precipitated at a given point is rather large. (APB)


The mechanism of the use of sound waves for dust precipitation is explained. It is reported that sonic apparatus collects agglomerates of carbon-black particles issuing from the combustion chamber as efficiently as a dry electrostatic precipitator, with a cheaper installation. Other fields where the method appears promising are in the precipitation of acid mists and tar fogs, which are difficult to handle by other methods. Preliminary tests with natural fog indicate that power consumption may be great, but is only one-tenth the amount consumed as fuel by the FIDO installation, which burns the fog away with flame. (APB)

A brief historical survey is made of experimental work on aerosols from 1871 to 1943 and their properties are given. The chief methods by which they can be produced are described, and the essential features which should be possessed by a practical commercial apparatus are enumerated. The Phantomeyer equipment developed by Aerosols, Ltd., which embodies these features, has proved extremely effective when used with the correct liquids for destroying bacteria and insects, administering drugs, etc., for therapeutic purposes, and neutralizing poison gases used in warfare. An account is given of recent research of the first two applications. (FA)


Practical formulae are developed for determining the effect of different physical and structural factors on the efficiency of the collector and also for determining the best yield obtainable under a given condition. The physical laws involved in separating dust from a gas are discussed in detail. In practice, it was found that increasing the temperature of the gas from 0° to 400° increased the weight of dust not collected by 5 per cent. A reduction in density of the dust particle from 1.0 to 0.8 increased the weight of dust particles not collected by 60 per cent, due to the film of gas. Each apparatus has its optimum speed. Dynamic dust collectors are not satisfactory for tiny particles (microns in size), for toxic dusts, or for the recovery of valuable dusts, where 100-cent per cent efficiency is desired. Recent progress suggests an ultimate yield of 92-95 percent. (APB)


Ducting systems: Dust chambers, baffle separators, centrifugal separators, and cyclones are described and advantages of the latter type, influence of particle size, and views on the choice of a system are discussed. (APB)


The Pulverized-Fuel Conference, Harragote, June 1947, showed that the main problem of atmospheric pollution today is the collection of dust from powdered fuel boiles. The cost of this operation and methods of dispersal of collected dust are discussed and notes are given on the performance required of dust-collecting plants, methods of testing dust collectors, and the dispersal of dusty flue gases from high chimneys. In dealing with improvements in dust-collecting devices, cyclones, cyclones with skimming devices, two stage systems, electrostatic precipitators, combination of cyclone and precipitator, film washers and combination of spray and film washers are discussed. The performance of existing plants for sulfur dioxide removal and methods for its recovery from boiler flue gases at existing and new power stations are studied. (FA)


The justification for and advantages of fitting Lan- cashire and similar boilers and auxiliaries with stationary flue-dust-removal equipment are discussed in some detail. (FA)


After a brief review of the development of the multicyclone collector a description is given of a collector of this type manufactured in the United States. This is of equal or even higher efficiency than the electrostatic precipitator used exclusively up to now for cleaning flue gases from pulverized-fuel boilers. In England the collector has been installed with success at the Peterborough power station. Compared with the electrostatic precipitator, this collector has higher power consumpion but requires less space, is much lighter, costs less, and requires no maintenance. (APB)


Electrostatic precipitation of dusts is particularly applicable to the very fine dusts, which are the most dangerous. The method is of great value in sulfuric acid plants, where it is used to separate arsenical vapors. It is also employed in coke ovens and in other enterprises where valuable or dangerous products occur in a fine state of division. It has been found more efficient than other methods and the cost is moderate. The method has many other advantages. (APB)


A small electrostatic precipitator is described which enables the determination of the dust content of gases, including those which are inflammable and have dew points above room temperature, the majority of the dust particles concerned being below 1 micron in diameter. The precipitator tubes, electrical layout, and ancillary equipment are described, and also the technique developed to avoid ignition of the gas, loss of dust by condensation in pipelines, etc. Some examples of results obtained when using the precipitator to determine dust concentrations in producer gas with dew point 60° are given and discussed. (FA)


Electrostatic equipment of a type described adapted to treat a gas flowing longitudinally, comprising a hollow, cylindrical gas duct, electrode means comprising a first group and a second group of substantially coextensive juxtaposed hexagonal tubes, the tubes of each group being secured together inside the cylindri- cal gas duct, sealing means for close fit between each of the groups of tubes and the cylindrical gas duct, the sealing means being secured to each of the groups of tubes and to a cylindrical gas duct, a plurality of bar members carried by the cylindrical gas duct, and extending transversely across it at the ends of the tubes, a plurality of insulators carried by the bar members, the insulators between the groups of tubes having longitudinal bars secured thereto, transverse grating means carried by the insulators at the far ends of the tubes, transverse grating means carried at each end of the longitudinal bars, and electrodes carried by the grating means axially passing through the tubes, in insulated spaced relation thereto. (APB)


A schematic air-flow diagram of the electrostatic dust sampler is given together with a circuit diagram. (APB)


The fundamental principles of electrostatic precipitation are explained, and Cottrell's early work is outlined. Single- and two-stage methods of precipitation
and mechanical and electron tube rectifiers are considered and their advantages enumerated. Precipitators of the dry type, suitable for use in power plants for removing fly ash and soot from steam, and of the wet type, which are preferable for many chemical processes, are described. Methods for removing dust from the collecting electrodes without dispersing it in the gas stream are given, and the choice of material for various forms of enclosure or shells is discussed. (APB)


The dust-laden gas is passed through a bank of cyclone tubes 6 inches in diameter, and means are provided whereby its direction of motion is suddenly reversed, causing the dust to be deposited. (APB)


Claim 1: A dust sampler comprises in combination a filter tube having an inlet and a dust-collecting device having an outlet in the throat of the venturi tube, so that the passage of a gas through the venturi tube, from the direction of its inlet is adapted to draw gas through the dust-collecting device. (APB)


The process, types of equipment, installations, and typical applications are described. (FA)


Claim 1: An air cleaner comprising: A hood having cylindrical walls and an enclosing top wall; a dust cup within and connected to the hood having walls substantially paralleling the cylindrical walls of the hood and spaced therefrom forming an annular air chamber; an annular flange on the cup engaging the cylindrical walls of the hood and overhanging a portion of the air chamber; annular air deflecting walls carried by the cup walls and overhanging another portion of the air chamber; short cylindrical walls connected with the peripheral portions of the deflecting walls and joining the inner edge of the flange with the deflecting walls, thereby forming a relatively narrow chamber air zone between the short cylindrical walls and adjacent walls, there being a dust passage from the zone into the dust cup; and means for directing air into the chamber and means for directing air from the air chamber. (APB)


Claim 5: In an air cleaner, a casing having a liquid sump in the bottom thereof and an inlet opening above said sump, a filter holding shell in said casing above the sump and spaced from the casing wall to provide an inlet passage leading toward said sump, a filter mass in said shell, said shell having an opening in the bottom to provide unrestricted communication between the filter mass and the sump therebelow, said shell having a series of tongues struck inwardly from the side wall of the shell and extending inwardly and upwardly into the filter mass, said tongues leaving openings above the outer terminations of the tongues in the side wall of said shell above said sump to by-pass air travelling reversely through the cleaner due to back pressure and guide such air in a direction in connection with reversely traveling air that reached said sump and said casing having an outlet for air passing through said filter mass in the forward direction. (APB)


Claim 1: In an air cleaner, a casing having spaced inlet openings and slanted to define a liquid sump, a removable filter element in the casing in the path of air travelling from the inlet to the outlet, means to hold the filter element in position within the casing, and means projecting from the filter element to limit the movement of the element in case the element becomes free, the last means also being connectible to the first means with the filter element in inverted position, the filter element being arranged to function with equal efficiency in either position. (APB)


The object of the invention is to remove from gases the dust particles drawn along therewith, whatever their origin and whatever the temperature and pressure of the gases. It may be applied to the separation of dust particles from the hot gases issuing from a boiler and especially from a boiler heated by gases under pressure. (APB)


This relates to the removal of dust from high-temperature gases, and particularly relates to removing dust or catalyst from gas regeneration processes. (FA)


Claim 1: Apparatus comprising a dust leading from a dust collector to which the dust from the collector will fall by gravity into a bell of substantially larger diameter than the duct, a receptacle at the lower end of the bell providing a water seal therefor and means for maintaining a flow of water through the receptacle. (FA)


A broad review is given of the technical aspects (design and efficiency) of dust-extraction systems at power stations, with a drawing of the Bowden multig cell arrester. (FA)


The technical aspects of dusting systems are examined, with reference to dry and wet systems, electrostatic precipitation, and multigcell arresters of recent development. The washing systems at Battersea and Fulham Power Stations are discussed. (FA)


Some important improvements in agglomeration of aerosols are claimed, and a description is given of how aerosols are subjected to sound waves to cause agglomeration. Other factors are also introduced, namely, heating, an electric field, ultraviolet or X-ray radiation, and reduction in temperature. (APB)


Experimental investigations have shown that a layer of nonconducting particles on the electrode of a precipitator distorts the field distribution in the corona zone. Measurements indicate that the outer corona layer is charged to a certain potential, depending on the properties of the precipitator, thickness of the layer, and corona current. The tests were carried out with reference to negative corona discharge. (APB)

A comprehensive account of modern practice. Current/voltage and field strength-distance characteristics are given for tubular precipitators. The influence of gas composition and temperature on performance is discussed, reference is made to the design of rapping gear and to the necessity of emptying and protecting the dust hoppers, and details are given of the high-voltage equipment. Capital cost, consumption of electrical energy, and efficiency of electrical precipitators in removing carbon and ash particles of various size ranges, are other subjects to which detailed consideration is given in this paper. (APB)


Claim 1: An electrostatic precipitator for removing dust and like impurities from dirty gas, comprising a container, a receiver electrode having its receiving surface within the container, a discharge electrode, means for mounting the discharge within the container in insulating relation thereto, the gas being adapted to be passed through the container between the electrodes whereby solid matter deposits on the electrodes, a rod passing through a wall of the container, the inner end of the rod being in rigid relation to the structure of the discharge electrode, insulating means for substantially sealing the rod with respect to the wall while maintaining the rod insulated from the wall, and mechanism mounted outside the container for rapping the rod and through the rod, transmitting shocks to the discharge electrode and thereby shaking off the deposit on the discharge electrode. (FA)


A report on small-scale tests on catalytic oxidation in solution of SO₂ to H₂SO₄. The fine ash obtained from various power stations containing iron, copper, and especially manganese, was used as a catalyst in the form of a suspension in water. (FA)

1947


Claim 1: In a centrifugal dust separator having an imperforate outer casing wall forming the separator chamber, the improvement which comprises a screen plate applied to an opening formed in the outer casing wall together with means to direct the discharge of material after passing from the chamber outwardly through the screen plate, comprising a chute embracing the outer side of the screen plate and provided with securing means facilitating outwardly removal of the chute and screen plate from the outer casing wall. (APB)


The deposition of charged particles upon the walls of a cylindrical conducting container as a result of electrical repulsion alone has been calculated for two cases: (a) A nonstirred condition of the aerosol: streamlined flow; (b) a continually stirred condition of the aerosol: turbulent flow. The results for both cases are the same. (APB)


Vacuum tubes give instant and accurate evaluation of dust-removal equipment. (FA)

1948


Claim 1: A series of discharge electrodes mounted in a tube and each provided with a number of discharge points, pointing in the desired direction of flow of air or gas through the tube are arranged at spaced points along the length of the tube so as to enable a discharge accompanied by the electrical wind to be produced between each of the electrodes and the next-following electrode by connecting alternate electrodes to the same pole of a continuous current source of sufficient voltage to produce the electrical wind. (FA)


Relates to units of the interleaved space parallel plate electrode type. (FA)


The liquid is introduced into the upper part of the separator together with the gas or vapor; the liquid falls freely through the apparatus while the gas or vapor is drawn in by rotary fans one above the other at the center of the apparatus. When rotating the fans divide the liquid finely, eject it, and mix it intimately with the gas or vapor. After each ejection the matter in question is collected at the middle of the apparatus by collecting funnels placed above the fans. (FA)


The factors that affect the size of solid particles emitted by pulverized-coal units and spreader-stoker furnaces are compared. Mechanical dust collectors are discussed, with emphasis on the aspect of cleaning flue gases to remove solid particles. Many collectors are not effective unless pressure is used, which is usually too expensive to justify installation. A method is proposed for using a cyclone collector. This high efficiency without high draft loss. This involves the expense of the pressure required to produce the necessary velocity at a given radius to achieve the desired separation and the kinetic energy so produced is then transformed back into pressure energy after the cleaning cycle so that the net draft loss is of a permissibly low value. This type of ash collector meets with the requirements of the community and can be installed with the existing stack and breeching and requires no induced draft fan. For the given pressure drop, the centrifugal acceleration is comparatively high, resulting in a high efficiency of separation. (FA)


Claim 1: Apparatus for removing dust or other particles from air or gas wherein the air or gas first impinges against vanes or baffles arranged in spaced relation and inclined to the direction of the air or gas, whereby heavier particles carried thereby are deflected by the vanes and fall by gravity on one side thereof, the air passing between the vanes or baffles to the other side thereof and then through a body of filtering material. (APB)
CONTROL OF AIR POLLUTION

Claim 1: Means for separating dust from a stream of air passing through a cylindrical tube open at the bottom, a second cylindrical tube extending with and downwardly from the top of the first tube and provided with an annular chamber, there being a space in the first tube between the lower end of the second tube and the inner end of the first tube, whereby the gas stream is given a whirling motion in the annular and vortex chambers, causing liquid in the reservoir to be mixed with the gas and thrown against the walls of the reservoir and the vortex chamber to increase the dust separating action of the means. (FA)

The methods of measuring drop-size distribution in fog and cloud have been fraught with difficulty and tediousness. Of the most accurate ways, that of electrical precipitation, is too delicate for everyday use. It has been employed as a check on a refined mechanical technique. The simplest mechanical method, that of placing an oil-coated plate in an airstream, selects droplets and retains them at a favorable rate. The capture coefficient (ratio of given-size drops captured to those passed) is calculated theoretically as a function of droplet speed, plate width, and size. Other things being equal, it is shown that the capture coefficient is the higher the narrower the plate and approaches unity as the width approaches drop dimensions. This fact suggests use of a network of very fine fibers. Flexiglas fibers were tried and the results found to compare favorably with the electrical methods. Much caution, however, is still required in employing such direct-counting techniques and indirect means, such as those utilized by the recently considered optical instruments, appear to be more promising. (APB)

Considers the several methods of collecting solids from the air. All cities are urged to establish and use a jar-collection system, such as is outlined, for a complete determination of air pollution areas. There is no indication that a better system will ever be discovered or invented.
Includes detailed instructions for the jar-collection method.

New precipitators are reported to be 95 percent efficient for solid or liquid particles in industrial gases. They are used for removal and recovery of tar oil and water from coke oven gas, to clean blast furnace gas, to remove dry dust from grinding mills, etc., and for removal of fly ash from power plant boiler gas. (FA)

A multilayer cellulosic filter medium (Almator paper) which, when statically charged, tends to separate into its plates, and each individual fiber becomes a collecting electrode for smoke particles. Made by the American Air Filter Co. (FA)

Relates to improvements in cyclone dust collectors and has for its object the provision of improved constructions whereby a large percentage of the dust may be removed from dust laden-air in a cyclone separator. (FA)

Claim 1: A series of discharge electrodes mounted in a tube and each provided with a number of discharge points pointing in the direction of flow of air or gas through the tube are arranged at spaced points along the length of the tube so as to enable a discharge accompanied by the electrical wind to be produced between each of the electrodes and the next following electrode by connecting alternate electrodes to the same pole of a continuous current source of sufficient voltage to produce the electrical wind. (APB)

A survey of the problem of dust extraction is presented and the various systems whereby it can be employed on a gasworks are outlined. (APB)

Ultrasonics are vibrations above about 20,000 c. per sec. The development of more powerful means of producing ultrasonic waves led to an investigation of their properties and many possible applications were proposed, although relatively few have reached the stage of practical use. The possibilities include direction and depth sounding, geological surveys, examination of metals for flaws, dispersion of metals and colloids, emulsification, coagulation of aerosols, etc. The methods of production of ultrasonics and a description of their effects and practical uses are given. (FA)

Claim 1: A centrifugal type dust separator for separating solid particles from extremely hot gases comprising: A chamber having an inlet for the hot burdened gases, an outlet for the unburdened gases, and a collecting compartment for the solid particles separated from the gases, the chamber being shaped so as to impart abrupt changes in the direction of flow of the gases therethrough so that the solid particles entrained by the gases are separated therefrom by the inertia of the moving particles; and a substantially imperforate protective covering for the inner walls of the separator for precluding contact of the hot gases with the separating surfaces of the separator walls during passage of the gases through the separator, the protective covering comprising a series of closely adjacent fluid passages through which a coolant is circulated. (FA)

In a series of experiments a cloud of fine quartz dust of less than 1 micron diameter was produced. The dust particles were invariably mixed with aerosols generated from distilled water and dextrin, following which means diameters of the individual particles increased from 50–100 percent. The results suggest that aerosols may be useful to facilitate and supplement current methods for the more adequate control of dust hazards in various occupations. (APB)

This report presents the results of studies to determine the relation between aldehyde content of diesel exhaust gas and the odorous and irritating properties of that gas and to determine the effectiveness of dif-
ferent scrubbing media for removing aldehydes from diesel exhaust gas.

Observations on odor and irritation produced by diesel exhaust have shown that both of these properties can be correlated with the concentration of aldehydes in the gas. The threshold concentration of perception of odor is approximately 0.2 to 0.3 p. p. m. aldehydes, expressed as equivalent formaldehyde. The threshold of nasal and eye irritation occurs at about 1 p. p. m. of aldehydes. A series of full-scale tests on the removal of aldehydes by scrubbing with water showed that as the concentration of aldehydes in the scrubbing solution increases, the percentage removal of aldehydes decreases. At elevated temperatures, the removal was nil, and under no condition was complete removal obtained.

From a series of laboratory tests, it appeared that aqueous solution of sodium sulfite might be used in removing aldehydes from diesel exhaust gas if hydroquinone were added to inhibit the oxidation of the sodium sulfite. A full-scale test showed that an aqueous scrubbing solution containing 10 percent sodium sulfite, 0.5 percent hydroquinone removed substantially all aldehydes for a period of 7 hours and 90 percent or more of the aldehydes for a period of 15 hours. In this test, approximately 3,000 cu. ft. of dry exhaust gas (at 60° F. and 29.92 inches Hg) was scrubbed per hour at a scrubbing temperature of 132° F. Estimates of the cost of scrubbing diesel exhaust gas indicate that the cost of materials would be approximately 80 cents for an engine operating continuously for 8 hours and producing an average of 5,000 cu. ft. of dry exhaust gas (at 60° F. and 29.92 inches Hg) per hour. (USPHS)


The electrostatic deduster enables dust particles to be removed better than with mechanical filters. The air carrying dust on entering the precipitron passes first through the ionizer, where some of the cells have a negative potential (−6,000 volts approx.). The dust particles are precipitated on plates by electrostatic attraction and washed off by water. The precipitron has many advantages, such as retention of microsized particles, high efficiency as measured by the blackening method, easy installation, and low maintenance. It can be used in electric and telephone centers, chemical and textile factories, laboratories, public buildings, homes, etc. (FA)


In “equepressure” boilers in which the combustion chamber is under pressure (100 atm. or more), elimination of unburned constituents is essential before the gas enters the turbine or engine. The dilatite filter is a single stage and solves this problem. The gas is passed through a wall about 8 cm. thick of gravel of suitable size, held in position by a series of inclined shutters. If the gas is passed through at 0.5 meter per sec., 99.9 percent of the dust is held by the gravel. Pressure drop is about 12 mm. w.g. The contaminated gravel is then dropped onto a 2-mm. oscillating screen and returned by an elevator to the filter. The dust is run to a silo or returned to the furnace if rich enough in carbon for burning. Semi-industrial plant is described, adaptation for industrial scale is discussed, and diagrams are given of the proposed arrangement. (FA)


An illustrated description is given of an aerodynamic dust collector based on an entirely new principle of separation. In this equipment the filter surface consists of a specially slotted sheet bent into the form of a cone. The air or gas is passed at high velocity over the surface and owing to the form of the slots aerodynamic forces are set up and the resultant force on the dust particles is in a direction away from the cone face. This force keeps the dust particles suspended in the form of a thin cloud layer immediately in front of the filter surface while the clean air escapes through the slots. A table is given showing the collecting efficiencies when the dust collector is used under various conditions, taken from actual tests. (APB)


Brief reference is made to the Howden vortex system of dust and soot extraction from fumig gases, which has been applied with satisfactory results to vessels of the principal British and foreign shipowners. It consists of one or more cylindrical chambers, which can be fitted in the uptakes in any convenient position between the boilers and the top of the funnel. The gases enter at the bottom of these chambers and are made to rotate upward and tangentially by an arrangement of fixed vanes. This sets up a vortex within the chamber, and the particles of soot or grit are thrown out by centrifugal action to the periphery of the collector. There are alternative methods of extracting the dust. (APB)


Basic factors in the design and performance of cyclone dust collectors. Theoretical and empirical formulae for cyclone performance that are now available indicate that some minor constants must be determined through experiment; they indicate the need for additional information regarding the cyclone collector. The formulae are shown and methods of their working are described. (FA)


Particles suspended in an air stream moving spirally separates into (1) those flung to the periphery by centrifugal force, (2) those carried toward the center, owing to friction of air to particle. A centrifuge built on this principle is described. Dust-laden air enters between two rotating parallel disks, and the speed of the air stream determines the critical grain size. Design details are given, errors and their effects are discussed, procedure is described, and some results of analysis are given. (APB)


Use is described of an out-of-balance electric motor for vibrating the electrodes of an electrostatic precipitator. (APB)


A liquid-bath air cleaner with a casing through which the air flows and with a liquid sump in the bottom of the casing and a filter in the path of the air from the inlet to the outlet of the casing, including a filter holding shell bonded to the inside wall of the casing in one region and spaced therefrom otherwise
to define a passage for the entering air leading toward the pump. (APB)

2718. Filter Element or Unit for Air Cleaners and Method of Making the Same. British Patent 613,446, 1948.

Claim 1: A method of making an air-filter element or unit from vegetable fibers, including the step of curving the vegetable fibers around a mandrel, treating the curved fibers to set the curl, and bending the curved fibers together at random into a uniform mass. (APB)


A dust filter in which one or more bags extract the dust from dust-laden air or gas while it is passed through the pores of the bags, these being periodically agitated and at the same time subjected to a counter-flow of air or gas to remove the dust from them. This invention provides a simplified and efficient means for effecting the periodic agitation of the bags and reversal of air or gas flow. It comprises a dual cam having a section provided with slots adapted to effect the shaking of the bags and a section adapted appropriately to operate the control valves for the air or gas, the valves being loaded so as normally to occupy the position in which dust-laden air will flow to the bags and scavenging air will pass to the cam section which operates the valves being arranged to hold them in the opposite position, that is, the position in which scavenging air will flow to the bags to be cleaned and dust-laden air will not, against the action of the loading means provided for the first-mentioned section of the dual cam effect the shaking of the bags to be cleaned. (FA)


This new collector (système Linderoth), is based on a new principle of separation, and is designed to overcome difficulties inherent in the normal type of centrifugal collector. The filter surface consists of a specially slotted sheet bent into the form of a cone. The air or gas to be cleaned is passed at high velocity over this surface, and, due to the form of the slots, aerodynamic forces are set up, the resultant force on the dust particles being in a direction away from the cone face. This force keeps the dust particles suspended in the form of a thin cloud layer immediately in front of the filter surface, while the clean air escapes through the slots. These slots or passages for the clean air are many thousand times larger than the dust particles which are removed, so that even with adhesive dusts there is little tendency for the filter to become clogged. (FA)


An air filter, known as the Precipitrion filter, utilizing the principle of the electrostatic precipitator and giving a similar performance, has been developed by the Sturtevant Engineering Co. It has been brought within the range of reasonable capital cost by adopting standardization of parts and is being produced in sizes suitable for use in commercial and industrial air conditioning systems. The filter is assembled in three parts—the ionizer, the dust-collecting cell, and the power pack. The filter is described. (FA)


In a flue-duster boiler suitable for installation in a boiler pass with gas temperature up to 1,000°C, louverors in wedge-like formation change the direction of gas flow by 90 degrees. The particles in the gas unable to follow the sudden change of direction, are projected through an opening in the boiler wall into the cyclone while the gas returns to the gas pass of the boilers. The louverors can be water-cooled if desired. (FA)


A dust collector having a gas duct with an inlet at one end and an outlet at the other end above the cyclone and having the cyclone casing divided by a substantially horizontal partition provided with a series of circular apertures to receive the upper ends of the cyclone inlet tubes with a pair of substantially horizontal plates disposed above and spaced apart from the horizontal partition, each plate having a series of circular apertures to receive the upper ends of the cyclone outlet tubes, which ends are aligned in one plane, and walls dividing the space above the pair of plates and in the duct to provide inlet passages between the duct inlet and the cyclone inlet tubes, and outlet passages between the cyclone outlet tubes and the duct outlet, in which each horizontal plate has a pair of upwardly extending walls, the upper portions of which are substantially triangular with their apices meeting the upper wall of the gas duct at its central portion, and further walls cooperating with the triangular walls and the side walls of the gas duct to provide the inlet and outlet passages between the cyclone tubes and the inlet and outlet. (APB)


The dispersion and deposition of aerosols is considered on the basis of Sutton’s theory for the diffusion of gases in the lower atmosphere and Selig’s work on the efficiency of deposition of particles by impaction. An estimate is made of the rate of deposition of particles dispersed from a line source under various meteorological conditions. The impaction curves have been applied to the penetration and deposition of insecticidal aerosols through a forest canopy. Under conditions of low wind and in the absence of a downdraft, according to the theory, the larger particles will penetrate the canopy better than the small. The opposite is true, however, when the deposition depends on the downdraft from a plane. Selig’s curves may also be used to predict the effect of the drop size of aerosols on the mortality rate of moving and stationary insects. The calculated results agree closely with the experimental observations of La Mer and coworkers. (FA)


The elutriator described in detail is a modified form of the R. S. model incorporating two major differences—the use of a sintered glass plate for supporting the dust and a glass-wool collector for quantitative results. It can be used with dusts of high caking propensities, giving results of dust content more accurately and readily related to conditions obtaining when dusts are dispersed in air. The results are given of a typical run of 20 grams of Derbyshire limestone (54 percent passing 240 B. S. I.) in which air was passed through the elutriator at 1.5 liters per minute, the separation of fractions, as checked by microscopic examination, was good and the proportion elutriated reproducible within 1 percent. Losses were low. (FA)


Describes an instrument that employs the principle of thermal precipitation for taking continuous samples
of airborne dust over periods up to 24 hours. The dust is deposited on a 3- by 1-inch glass slide; this moves slowly past the wire by means of a clockwork mechanism, which may be altered to permit a series of samples to be taken. Paper also describes methods of examining deposits and calculating results. (APB)


The Koppers-Eley electrostatic precipitator is described briefly. (APB)


Statistical methods of determining the efficiency of electrostatic gas cleaners are explained. (APB)


Practical formulas are developed for determining the effect of different physical and structural factors on the efficiency of a cyclone separator and for determining the best yield obtainable under a given condition. The physical laws involved in separating dust from a gas are discussed in detail. In practice, it was found that increasing the temperature of the gas from 0° to 400° increased the weight of dust particles collected by 50 percent. A reduction in density of the dust particle from 1.8 to 0.8 increased the weight of dust particles not collected by 60 percent, owing to the film of gas. Each apparatus has its optimum speed. Dynamic dust collectors are not satisfactory for collecting tiny particles (micron size) and toxic dusts or for recovering valuable dusts, where 100-percent efficiency is desired. Recent progress suggests an ultimate yield of 92 to 95 percent. (FA)


The Musgrave aerodynamic dust collector is described. The filter surface consists of a specially slotted sheet bent into the form of a cone. Slots are placed in such a way that dust particles do not come in contact with the filter surface, and therefore erosion is not high. There is little tendency for the filter to become clogged. (APB)


An electrostatic dust precipitator for cleaning a gas flow. (FA)


The theory of operation of cyclones is discussed, and a "factor of separation" is derived which is equivalent to $Vt/R$, where $Vt$ is tangential velocity and $R$ is resistance to movement of the particle in the fluid. $R = k/v$ for spherical particles, $v$ is velocity, $d$ is particle diameter, and $k$ is viscosity of the fluid. Based on the factor of separation, large-diameter cyclones are less efficient in separating fine particles than would be expected. The poor efficiency of some cyclones is indicated by a test in which blast-furnace gas entering the cyclone with a dust content of 22.4 gm. per cm. cu. left it with 19.8 gm. per cm. cu., only 11.6 percent of the dust being retained. Several experimental cyclones, illustrated by sketches, were made on a 5.20 scale of tinplate and one of zinc. In trials with cemen dust the first model separated out only 35 percent of the dust. By replacing the ring of blades under the gas exit this was increased to 55 percent. When the ring of blades was removed and the wide gas exit was replaced by a narrower funnel-shaped one, separation was raised to 75 percent. These experiments and conclusions led to a model (d), which proved to be the most efficient. Results with this model and the others are shown on a 3-dimensional perspective, axes being (1) percentage separation, (2) gm. dust/cm. cu. (5 to 30), and (3) gas velocity (5 to 20 M/sec.). With model (d), separation was usually 80 to 90 percent, increasing slightly with velocity and with dust content. The latter effect was even more pronounced with the other models. (FA)


Large-scale application of high-frequency sound waves in industry has been developed. A high sound-wave intensity can be achieved with a new sound generator developed by the Ultrasonic Corp. Its main use has been in aerosol agglomeration. The recovery of smoke, dusts, and mists can be effected by this means. The generator is essentially a high-speed air siren, driven by a variable-speed turbine. Frequency is governed by the speed of rotation, and intensity by the amount of air admitted to the generator. In agglomerator towers the sound generator is placed at the top, and the sound vibrations are directed downward. The generator was first applied industrially in the manufacture of furnace black from natural gas, giving a 96-percent recovery. The intense sound waves give the particles a wide velocity distribution, leading to more collisions and thus to agglomeration. Particles 15 to 100 microns in diameter are the largest to be affected in this way. Subsequent separation by a cyclone separator is greatly facilitated. Other projected applications include soda recovery from stack gases, salt-cake recovery, sugar-opening, dust collection, dust recovery from fuel gases, and dispersion of natural fog. Its use as an aid to spray drying and certain applications in the liquid-solid field are also considered. (FA)


A description of the Babcock & Wilcox E type dust mixer for conditioning dry dust, by admixture with water, for convenient disposal. (FA)


A new apparatus, designed for almost complete (97 percent) purification of different gases containing very fine dust particles, is described and illustrated. It gave satisfactory results when tested at several stations of the Moscow underground railway. (FA)


Describes solution of a problem of corrosion causing complete failure of the housing for electrostatic precipitators, which are installed between boilers and induced-draft fans in power plants. After several other methods failed insulation was applied to the outer surface of the ducts, thus preventing radiation of heat and making it possible to hold the temperature of the precipitator chamber above the dewpoint of the stack gases. This prevented the moisture condensation responsible for corrosion. (FA)


Describes the flocculants, flocculation tests, and method of conducting batch flocculation tests. Gives measurement of density of aerosol and degree of flocculation. (FA)

Apparatus for separating finely divided solid materials from gaseous carrier materials comprises a housing, outlet means for the withdrawal of gaseous materials substantially free of solid materials arranged centrally of the top portion of the housing, a rotatable separator bowl of inverted virtually conical shape arranged centrally of the housing, a plurality of vanes arranged on the inner walls of the rotatable separator bowl, a conical member forming the base of the separator bowl for collecting materials to the inner walls of the separator bowl, an inlet pipe means for the supply of mixtures of finely divided solid materials and gaseous carrier materials to the separator bowl, the inlet pipe means being arranged centrally of the rotatable separator bowl and being flared at its lower end for smooth discharge of incoming mixture directly against the conical member forming the base of the separator bowl, means for rapidly rotating the separator bowl, and means for withdrawing separated solid materials from the bottom portion of the housing. (FA)


The cyclone separator is discussed under the following heads: Principles of the cyclone separator; influence of the depression within the separating chamber; formulas for calculating the depression; applications of the vertical motion on precipitation; and calculation of the capacity of a cyclone. (FA)


Electrostatic dust-separating filter comprises ionizing and collecting electrodes, in which the collecting electrodes rest freely on a resiliently mounted rigid support. Electromagnetic means are provided for imparting vibrations to the support during brief periods that take off dust adhering to the collecting electrodes. (FA)


Dust separator of the cyclone type comprises a plurality of partitions inside the external body. Each partition has an outlet through which passes part of the air charged with dust circulating against the partition; this quantity of air is fed toward a separate dust extractor. (FA)


This apparatus is an improvement or modification of the invention claimed in British Patent 593,156, a dust separator for gas under positive pressure. (FA)

2746. STEAM ENGINEER. Howden Vortex Dust and Soot Collector. Vol. 18, 1948, pp. 119–120.

Collectors for the extraction of soot and dust from funnel gases on marine installations are of two types—dry and wet. The gases are made to rotate upward and tangentially by an arrangement of fixed vanes, and 84 percent of the particles 66 microns or more in diameter are efficiently extracted by a secondary cyclone collector of the dry type and by a descending water film in the wet type. This latter type is 97 percent efficient. (FA)


Describes the first of this firm’s electrostatic precipitators made exclusively for use in textile mills. It consists of three parts: The ionizer, the dust-collector cell, and the power pack, which are illustrated. The removal of “99.9 percent of obnoxious dust and dirt from the atmosphere of the mill” and an efficiency of 90 percent on the “blackness test” are claimed. (FA)


Some important improvements in agglomeration of aerosols are claimed, and the method of subjecting aerosols to sound waves to cause agglomeration is described. Other factors are also introduced, namely, heating, an electrostatic field, ultra-violet or X-ray radiation, and reduction in temperature. (FA)


Methods of minimizing the effects of fumes on factory air-purifying equipment are discussed. Dustwork can be coated with resistant paints and is, in any case, normally replaceable without much difficulty, although not without considerable expense. Of greater importance is the fan impeller, the sudden failure of which can cause irreparable harm, even if nothing worse than a production stoppage occurs. In this connection, special interest attaches to the ejector system, in which the fan is in contract with a only, and the venturi outside ejector principle. (APB)


An electrostatic precipitator in which an equal or approximately equal flow of gas through the individual elements of electrostatic precipitation plant is insured by the provision of plate blocks appropriately shaped and positioned. (APB)


A method of preventing the formation in or the removal of dust from air wherein either air that contains dust is subjected to the action of a finely divided aqueous solution, containing a small proportion of each of a nonsoapy anionic surface-active substance and of a water-soluble mucilaginous or like adhesive substance, or working surfaces capable of giving rise to dust are treated with such a finely divided solution. (FA)


An electrical precipitator of the two-field type comprising vertically disposed earthed plates or tubes, charged stretched wires suspended in spaced parallel relation with these earthed plates or tubes, and charged plates or tubes suspended near or in contact with the charged wires, over a part of their length, so that no substantial discharge current takes place from this part of the wires, while the remainder of the wires are left free to give the required current discharge. (FA)


The application of ultrasonics or supersonics in the coagulation and precipitation of extremely fine gas- or liquid-borne particles is considered. The current status of the science and the energies involved are discussed. Probable uses are suggested, and three standard experimental power generators—piezoelectric transducers, magnetostriction, and the Hartmann whistle—are described. The effect of ultrasonics on personnel is mentioned. (FA)

AIR POLLUTION—A BIBLIOGRAPHY


The elementary principles are outlined, and the development of the technique is discussed. Modern American practice is discussed, and a useful bibliography is appended. (FA)

1949


A process is described for removing hydrogen sulfide from waste gases produced in oil processing and converting it into elemental sulfur. Concentrated diethanolamine solution absorbs the gas in the scrubbers. The diethanolamine is then steam stripped to release the hydrogen sulfide, which is dried in shell and tube units. The gas is then burned with a deficiency of air, the products passing through a cyclone to remove the elemental sulfur and then through two catalyst beds to react the sulfur dioxide formed in the combustion with hydrogen sulfide. An overall yield of 98.5 percent elemental sulfur is reported. (IHID)


In the calculation of gas-cleaning apparatus, such as cyclones or dust precipitators, it is generally assumed that the flow inside the apparatus is laminar, whereas actually it is turbulent. The sedimentation processes therefore differ widely from the assumed ones. Because of turbulent flow, some particles fall short of the sedimentation surface, and some are carried off the surface after they have settled out. Actual calculations of sedimentation in a turbulent flow are difficult, but, close results can be obtained by basing the calculations on statistical means of turbulent scattering of dust particles toward the retaining surfaces. (FA)


Developed in 1942, the type N Roto-Clone is a hydrostatic precipitator that cleans the air by the combined action of centrifugal force and a thorough intermixing of water and dust-laden air, thus removing the water without recirculating pumps or spray nozzles. The new design of type N Roto-Clone, with capacities through 48,000 c.f.m., maintains a lower pressure drop, with the same cleaning efficiency and water-recirculation rate and can be operated at 50 to 120 percent of its nominal rating without affecting its collecting efficiency. (APB)


Discusses dusts, samplers, collection of samples, counting dust of the samples (light- and dark-field), and relation between precision of the dust counts (light and dark-field).


The Vieille Montagne Chemical Works (Belgium) was producing gas from a gaseous stream in which the air was carried, comprising a casing defining a chimney-stack portion, upward converging inclined walls separating the casing internally into an inlet chamber and laterally spaced particle-collecting chambers, a plurality of closely adjacent vertical conduits extending through the walls and terminating at their lower ends adjacent to the walls and at their upper ends substantially in a horizontal plane, grid-bar means extending across the casing and rigidly supporting the upper ends of the conduits, spinner members, one spinner member being positioned in the outlet-end portion of each conduit, a turntable on the casing, a plurality of outlet conduits extending through and sealed in the top wall, the outlet


The midget-impinger method for collecting and analyzing airborne dust has been used to make a dust survey in a small industrial town in Pennsylvania. Although the results are relative and depend on a number of factors, they indicate that the method can be used with reasonable satisfaction for locating dust-producing areas. The major advantages offered by the method are: An extensive survey can be made in a few hours; the equipment is rugged and easily portable; and it is not necessary to employ highly skilled help to collect samples. Limitations of the method are discussed. (20 refs. cited) (Authors' abs.)


Standard tests for dust suppression should be arranged. Cost of research should be paid by the community, since cupola-dust suppression, unlike fume-dust recovery, does not give valuable byproduct returns.


A new method of separating dust from a gas stream, as applied in the aerodynamic dust collector (Lincoln system), is discussed. It is claimed that when a current of air is directed at an acute angle against a slotted surface, a wavelength and thus the frequency depend on the relation between the pitch of the perforations and the velocity of the air current. If finely divided material (that is, dust) is introduced into the air stream, aerodynamic forces due to the wave motion act on each particle, and the resultant of these forces acts on each particle in a direction away from the slotted surface; within certain values of velocity and pitch of slots, the result of each particle is strong enough to maintain the particles in the air stream at some distance from the slotted surface. (FA)


Physical variables involved in the design of industrial aerosol agglomeration and collection systems for the recovery of fine particles in gases are discussed. Included are intensity and frequency of the sound field and exposure time of the aerosol to the field of installations used industrially to collect sulfuric acid fog and soda ash from the recovery boiler of a paper mill are cited. Finally, the characteristics of the particular types of industrial sub-particle collection problems that have been found to lend themselves to sonic agglomeration and collection treatment are evaluated, and many process industries having collection problems for which sonic collectors may be used are mentioned. (5 refs. cited) (Authors' abs.)


Claim 1: Apparatus for separating particles of material from a gaseous stream in which they are carried, comprising a casing defining a chimney-stack portion, upward converging inclined walls separating the casing internally into an inlet chamber and laterally spaced particle-collecting chambers, a plurality of closely adjacent vertical conduits extending through the walls and terminating at their lower ends adjacent to the walls and at their upper ends substantially in a horizontal plane, grid-bar means extending across the casing and rigidly supporting the upper ends of the conduits, spinner members, one spinner member being positioned in the outlet-end portion of each conduit, a turntable on the casing, a plurality of outlet conduits extending through and sealed in the top wall, the outlet
conducts being aligned one with each of the first-named conduits, and vertically positioned wall members extending downward from the top wall and terminating above the inclined walls, the vertical wall members being laterally spaced from and surrounding the first-named and the second-named conduits to provide a separating chamber around each of the outlet conduits and a doctor passageway around each of the first-named conduits. (FA)


Sodium chloride aerosols induce aggregation of fine silica particles. With an intense electron microscope beam, silica-dust particles and sodium chloride crystals can be differentiated within the aggregates. (IHD)


Details are given of the most recent design of Sirocco cellular dust collector, which attains high efficiency over a wide range of boiler loads when collecting dust from stoker-fired or pulverized-fuel boilers. (APB)


Claim 2: The separation of solid particles of different sizes and/or weights from air or other gases contaminated therewith by passing the gas stream through an unobstructed gap formed between straight parallel walls of a channel, one at least of which walls is lined with textile fabric presenting a pipe surface to the gas stream, the cross section of the channel being such that the fine and/or lighter particles are brought into contact with the pipe due to vorticity and its length being at least such that the larger and/or heavier particles reach the pipe before the gas stream leaves the channel. (APB)


Former methods of determining the particulate concentration in aerosols have been slow and laborious; but within the last few years two different rapid electronic methods have been developed, and the scope and range of which are discussed. The first method depends upon light scattering and the second upon electrostatic charging of the particles.

In the first method a fine stream of aerosol, protected by flowing through a tube of pure air, passes through a spot under intense dark-field illumination and scatters flashes of light forward upon a photosensitive cell. Each particle, about 0.14 micron or more in diameter, causes an electrical pulse which is large enough, after suitable amplification, to operate a mechanical counter. This apparatus will count particles weighing \(5 \times 10^{-9}\) gm. at rates up to 1,000 per minute.

A second type of electronic counter depends upon the electrostatic charging of aerosol particles forced at high velocity through a fine jet to impinge upon a metallic collector. The electrical pulses imparted to the collector by particles of 2.5 microns in diameter or larger are amplified to operate a mechanical counter. The pulse amplitude is proportional to the square of the particulate diameter. This empirical fact has been explained in terms of the charging mechanism.

Both counters may be used to determine the size of the aerosol particles, with suitable electronic discriminators. The electrostatic device may be very useful for larger particles, while improvements in the photoelectronic counter may permit it to be used in counting particles even smaller than those counted at the present time. (30 refs., cited) (Authors' abs.)


Claim 2: In an air-cleaning device the combination with an air-circulating fan having a casing forming an inlet suction side and a pressure outlet side, the former extending vertically and open at its top, of a cylindrical screen axially supported above the top of the inlet, of a hollow drum depending from the screen and surrounding the inlet, vanes mounted in the drum, an air nozzle connected to the pressure side of the fan casing, extending vertically within and adjacent to one side of the screen, and a receiver on the exterior of the screen for the material dislodged by the blast from the nozzle. (APB)


A process was developed on a pilot scale for recovering fluorine from stack gases evolved in the thermal processing of rock phosphate to produce fused tricalcium phosphate. Florite, a by-product of absorbing the fluorite, is present as hydrogen fluoride, in a bed of lump limestone at temperatures above the dewpoint of the stack gases. The calcium fluoride reaction product separates from the limestone lumps in the form of fines; portions of the bed are withdrawn from the tower at intervals and screened to remove the fines, and the oversize (partly reacted limestone) is recycled to the tower with fresh makeup limestone. The pilot-plant product contained 80 to 85 percent CaF2, which is comparable in grade to commercial fluor spar. Florine recovery in the pilot plant, using a 4-foot depth of packing, was as high as 96 percent for extended periods of operation and was governed principally by the rate of removal of the reaction product. Calculations indicated that virtually complete recovery could be obtained by increasing the depth of tower packing to about 9 feet. A large-scale unit was constructed, which utilizes this process for recovering fluorine from stack gases in the TVA demineralization-scale plant in which fused tricalcium phosphate is produced by fusion and defloration of rock phosphate. (FA)


Claim 1: A multiecell dust collector wherein the direction of rotation of the gases in each cell is opposite to that in all adjacent cells.


A new aerodynamic dust collector (Linderoeth system) is described, in which the filter surface consists of a slotted sheet formed into a cone; air or gas to be cleaned passes at high velocity over the surface and, owing to the form of the slots, aerodynamic forces are set up. The resultant force on the dust particles is in a direction away from the cone face, thus keeping the particles suspended immediately in front of the filter surface, while the clean air or gas escapes through the holes. Collected matter is forced at speed to the outlet end or apex of the cone and passes into a secondary collector; the concentrated dust mixture is then precipitated into a storage bin, and the secondary air or gas is returned to the inlet of the cone for reprocessing. (APB)


The efficiency of deposition of aerosol particles on water droplets moving by centrifugal force across a rotating gas stream is calculated on the basis of Sell's theory of impaction. For accelerations of 100 X gravity the maximum efficiency is obtained with droplets of about 100μ diameter. Impaction falls rapidly for
particles below 2μ diameter, and deposition by diffusion becomes important for very small particles. The development of the wet venturi scrubber for collection of dust and absorption of gases during atomization of a liquid in a high-velocity gas stream is described. Large-scale installations of this device have given efficiencies of removal of fume from industrial gases between 92 and 99 percent. The efficiency is a function of the specific drop surface developed per unit volume of gas and depends also on the nature of the fume. (15 refs. cited) (Authors’ abs.)


The dispersion and deposition of aerosols is considered on the basis of Sutton’s theory for the diffusion of gases in the lower atmosphere and Sell’s work on the efficiency of deposition of particles by impaction. An estimate is made of the rate of deposition of particles dispersed from a line source under various meteorological conditions. Application of the impaction curves has been made to the penetration and deposition of insectal aerosols through a forest canopy. Under conditions of low wind and in the absence of the canopy, the theory predicts that the larger particles rather than the small will penetrate the canopy. The opposite is true, however, when the dissemination depends on the down-draft from a plane. Sell’s curves may also be used to predict the effect of the drop size of aerosols on the mortality rate of moving and stationary insects. The calculated results agree closely with the experimental observations of La Mer and coworkers. (8 refs. cited) (Authors’ abs.)


A centrifugal separator for separating nonclogous constituents from a gas. (FA)


The methods used in preventing general air pollution by waste gases and fumes from the Bound Brook, N. J., plant of Calco Chemical Division of American Cyanamid Co. are described. They include a Cottrell precipitator for sulfuric acid fumes, absorption of sulfur dioxide, hydrogen sulfide, nitrogen dioxide, and antrahydroquinone, fly-ash collectors, and a deodorizing system for mercaptans. (FA)


Electrical precipitator for purifying gas is described.


The term “monodisperse” implies preparations whose size distribution does not deviate by more than 10 percent from the mean value.

In 1941 the author cooperated in preparing for the first time such monodisperse aerosols from a variety of substances. He has outlined the theory of many of the optical properties of aerosols useful in determining mass concentration, particulate concentration, and size of aerosol particles. (28 refs. cited)


Airborne particles are collected on wires, cylinders, or slides exposed in a wind tunnel and measured by chemical analysis. The theory and the factors influencing accuracy are discussed. (FA)


Claim 1: A multicliff dust collector having a structure including a hopper for the reception of and collection of separated dust, a plurality of dust-separator cells within the structure, and mounted for the discharge of separated dust directly into the hopper, a dust-gas inlet conduit for supplying dust-gas to the structure, and arranged to distribute dust-gas to the separator cells, a clean-gas outlet conduit connected into the structure and arranged to receive clean gas from each of the separator cells; an independent dust separator exterior to the structure; at least one conduit between the independent separator and a point of the structure adjacent to the position of the inlet conduit and arranged to receive gas discharged from the separator cells into the hopper from a position above the collected dust in the hopper; a gas-circulating fan; and conduits connecting the fan with the independent separator and with the clean-gas outlet conduit, the fan and the conduits associated therewith being arranged to draw gas from the hopper to the independent separator and to the clean-gas outlet conduit, and with the fan and the conduits associated therewith being arranged to draw gas from the hopper to the independent separator and to the clean-gas outlet conduit. (APB)


Claim 1: In air-cleaning apparatus, an air-intake chamber; an air-cleaner unit within the air-intake chamber with its upper end bridging the cross-sectional area of the latter, the unit comprising end walls forming downwardly and inwardly inclined side margins, a series of partitioning members spaced vertically and upwardly inclined at each side of the unit and respectivly extending from an intermediate interior zone of the latter to the respective sides thereof. The intermediate interior zone provides a central descending airflow path within the unit. Spaces between the partitioning members provide a plurality of ascending airflow ducts leading outwardly and upwardly from the descending airflow path to respective open ends of the unit. Catch basins extend between the end walls intermediate inner margins of the lowermost partitioning members whereby to close the lower end of the descending airflow path and the airflow from the descending ducts, and interstitial separator material is mounted on the upper faces of the partitioning members contiguous to the ducts formed by the latter. (APB)


Mists composed of sulfuric acid droplets, 2 to 14μ in diameter, were filtered from air at substantially atmospheric temperature and pressure by passing this air up through beds of solids fluidized in a 2-inch tube. Beds of nonporous materials like silica and glass beads showed an impractically short life, but porous materials like commercial microspheres, silica gel, and alumina picked up over 5 percent by weight of acid before sticking and destroyed fluidization. Removal efficiency, defined as the percentage (by weight) removal of the acid mist from the air, was substantially constant during the life of the beds and independent of the entering concentration over the range of from 20 to 120 pounds of acid (100-percent acid) per 1,000 cubic feet. For a given fluidized bed, removal efficiency increased with increasing bed weight per unit area and with increasing superficial gas velocity. With porous solids of minus-170-mesh and a bed weight per unit area of 32 pounds per square foot, a maximum removal efficiency of over 90 percent was obtained, with a super-
ficial velocity of 3 feet per second, corresponding to a pressure drop of about 6 inches of water across the bed. Removal of air from ammonia-nitrate smokes by fluidized solids beds, now under study, shows results somewhat analogous to acid-mist removal. (FA)


An attempt has been made to describe what the fly-ash problem is in a small boiler plant and some of the methods for overcoming it. To summarize the possibilities, four points seem particularly important: (1) Installing conservatively designed stoker equipment or an agglomerating or traveling-grate type so that burning rates never exceed the value where the quantity of emission will constitute a nuisance; (2) where total fly-ash emission is low, but large particles are a nuisance in the immediate vicinity, a simple dust trap operating on natural draft may prove adequate; (3) where higher burning rates are to be maintained regularly, a simple low-draft-loss collector will ordinarily suffice; and (4) on spreader stokers and others operating at very high ratings, a high-draft-loss collector and indeed-draft modifications of the standard type. Eventually a lower cost collector unit will be designed as a better solution of the problem. (IID) (Author's summary)


The object is to leave the air inside the cyclone fully undisturbed in its natural flow and to arrange means for restricting the flow only inside the outlet duct at the top of the cyclone. (APB)


The sides of the cyclone form an angle of 20° at its apex, which is immediately adjacent to the apex. The change in angle may be made in steps or gradually. (APB)


Electrostatic precipitation is considered in uniform and in ionized fields, together with the function of tube precipitators and their application to the treatment of industrial gases, with a discussion of electrostatic projection of dusts, illustrated by diagrams and charts. (ID)


The instructions given in makers' handbooks for installing automatic instruments for gas analysis relate to normal boiler and industrial furnace plants, where conditions are usually comparatively stable. The performance of experimental combustion equipment may well be subject to sudden, frequent, and wide fluctuations, and some modifications are used of the standard methods of installation may be necessary if the instrument is to follow, as quickly and as accurately as possible, changes in the composition of the flue gases. These notes describe and discuss some such modifications which have been evolved in the course of experimental furnace work by the British Coal Utilization Research Association. They are intended to supplement and not to replace the instructions in makers' handbooks and have been written especially for the investigator who has to use the instrument for applications outside its usual range. The recommendations for installation are applicable to most automatic instruments for analysis of flue gases, but they are mainly the result of experience with one instrument, the Mono. This instrument and its method of operation are described, and an account is given of means of reducing possible errors. Two experimental modifications are described to enable the instrument to measure gases outside its normal scope. The paper is of topical interest in view of the forthcoming publication, by the British Standards Institution, of British Standard Codes on (1) Indicating and Recording Instruments for Flue-Gas Analysis and (2) Sampling and Analysis of Flue Gases. (FA)


A close examination is made of commercially available devices for dust collection, with comments on cyclone traps, centrifugal forces, tube separation, cyclone collectors, and multiple units. (FA)


A short description of vacuum-type flue-dust removal installations and the water-sluicing system for removing dust and clinker. (FA)


Claim 1: A separator for removing entrained solid particles from gaseous materials, comprising three vertical concentric vessels, the inner vessel open-ended at top and bottom, the top opening constituting a gas-discharge outlet, the two outer vessels closed at the top and tapered at the bottom to form restricted bottom openings in the respective vessels, the openings in spaced relation below the bottom opening of the inner vessel, an inlet connected tangentially into the upper portion of the intermediate vessel for introducing gases and entrained solids to the space between the inner and intermediate vessels, an outlet for the removal of solids at the bottom of the outer vessel, and slotted passageways in the walls of the inner and intermediate vessels for removing solids from the gaseous materials passing respectively therethrough.


Describes a cyclone separator, with equations showing the reasons for the known behavior of cyclones. Gives a table of cyclone performance. (APB)


Reviews the precipitator application and describes developments in the design, namely, insulator compartments, which were moved outside the gas stream to the roof of the precipitator, and a wet-recovery system located in the bottom of the precipitator to replace the more usual dust hoppers. Electrical equipment utilizing either mechanical or vacuum-tube rectifiers and located in cabinets has been developed, thereby reducing maintenance. (APB)


A combination boiler, dust collector, and heat exchanger is described. (FA)


Gives basic practical data on flue dust, its properties, formation, and methods of control. A diagram
gives the rate of fall of particles of various sizes, the micron sizes being compared with United States standard screen sizes. (FA)


After reviewing some of the fundamentals of the Cottrell electrical precipitation process, such as the meaning of the precipitation constant, the effect of acid and base conditioning, the occurrence of "back discharge," and the significance of the dust resistor, this paper discusses the dependence of resistivity upon temperature, humidity, and chemical composition. Following this, the importance of good gas distribution in the precipitator is emphasized, and by gas-flow diagrams it is shown that proper distribution may be obtained by carefully chosen corrective devices. Next, the rating of centrifugal Dust collectors is considered, and their tendency to collect particles selectively, depending upon size, is discussed. After recent trends in the theory and construction of centrifugal collectors are described, it is concluded that present theories are adequate for a general understanding of the centrifugal collection process but that many details of the design still require experimental verification. (Author's abs.)


Several investigators have observed that aerosols may be rapidly agglomerated by intense high-frequency sound waves. The recent development of powerful sound generators opens the way for industrial utilization of this effect as another means of removing suspended matter from smoke and fumes. The forces acting to cause sonic agglomeration are complex. The more important factors seem to be a combination of the following: (1) Cavitation of particles in a vibrating gas; (2) attractive and repulsive hydrodynamic forces between neighboring particles; and (3) radiation pressure. (11 refs. cited) (Author's abs.)


In discussing some of the possibilities of removing smoke and dust suspensions by powerful sound and supersonic waves, the statement is made that vibrations of 5,000 to 60,000 per second could be used to remove material from the air; and the effective range for agglomeration was in the audible band (up to 18,000) the frequency could be so attenuated as to produce no objectionable noise. Analysis of the effect of superpowered sound, by passing the waves through glass tubes filled with smoke of various types, fogs of oil and water, quartz dust, and other common air pollutants, had shown that the contaminating particles formed "wafers" which were suspended in midair at intervals equal to one-half the wavelength of the sound, the time for agglomeration varying from a few seconds to 10 or 15, depending upon the individual size and the concentration of the particles. A complex array of forces combined to drive individual particles together, the first theory to explain sonic agglomeration attributing the effect to the increased rate of collision resulting from the accelerated movement of the particles. Other forces similar to the phenomena that explained the trajectory curve of a baseball were also involved. (LAF)


Systems described include: The Prat-Daniel natural-draft grit arrestor applied to an Economic boiler; the streamline (Bartl-system) grit catcher; the Musgrave aerodynamic dust collector (Système Linderoth); the Keith-Blackman dust-separator fan; the Prat-Daniel Turbocollector; and the Prat-Daniel skimming damper. (APB)


On the basis of work carried out in 1939-46 a method is described of calculating the pressure loss experienced in a cyclone separator under various conditions of working by consideration of the flow in a cyclone. It is shown that spinning speed increases as the inverse square root of the radius up to half the radius of the exit pipe, and thereafter angular velocity remains constant. (APB)


A new dust collector has been developed for dealing with fine dust from either stoker—or pulverized-fuel—fired boilers, in which it is claimed simplicity and high operating efficiencies and low pressure losses. This collector can be fitted directly in the flue system. (APB)


Describes various types of electrostatic precipitators in use today. Their common characteristics are pointed out particularly the similarities of their electrical power requirements. (APB)


A large brewery in the north of Sweden has installed a plant for the recovery of the carbon dioxide content of its chimney gases. The process was developed by the Stockholm Institute of Technology in cooperation with the "Stal" and "Separator" companies. (APB)


The object of the visit was to obtain a brief review of the progress made in the art of electrostatic precipitation in Germany from about 1930 onward. The obvious sources of information were found in the works of Lurgi G. m. b. H., Frankfurt am Main, this firm being responsible for the supply of the great majority of equipment installed in Germany. Visits of inspection were also made to sites of installations and to the works of Zschokke Werke, Kaiserslautern, to the Karmap power station, Essen, and the works of I. G. Farbenindustrie, A. G., at Hochst, Ludwigshafen, Mar-Hüls, and Leverkusen. Emphasis was placed on the field of precipitation as applied to boiler flue gas cleaning and to the procuring of literature published in Germany since 1935 and of drawings illustrating modern practice. The general impression was that no spectacular advances had been made; in fact, from 1943 the industry had been severely curtailed. (FA)


Before, during, and after the 1939-45 war, various experimental investigations into the behavior of cyclone dust collectors were made in the laboratory of the Technische Hogeschool at Delft, Holland. The investigations aimed at the attainment of a better understanding of the action of the gas currents in a cyclone and at determination of the most efficient shape of a cyclone and the kind of dust for which a cyclone collector might be confidently recommended. The most important results of these investigations are briefly stated. It soon became apparent that all attempts to increase the efficiency of the appliance by the fixing of blades, spiral ducts, or any other contrivance for the
purpose of directing the rotating of the gases were of no avail, as they only resulted in checking the free rotation of the gases in the body of the cyclone. A simple theory of a cyclone can be made to determine the approximate size of the largest dust particles which may escape separation by a cyclone. The influence of varying volumes of gas on the efficiency of separation was determined; in a well constructed appliance it proved to be small. (APB)


Measurements have been carried out in a cold box on the nucleation of ice formation in supercooled clouds by silver iodide smoke particles. The smoke was produced by atomizing an acetone solution of silver and ammonium iodides into a hydrogen flame.

The measurements show that ice crystals do not form immediately on the silver iodide particles. The silver iodide can be regarded as greatly increasing the probability of ice-crystal formation. The number of effective nuclei which can be produced per gram of silver iodide from -10°C to 10°C at -20°C is 5. (refs. cited) (Author's abs.)


Claim 1: Centrifugal separating apparatus which comprises a centrifugal tube, an ottake pipe extending axially into the tube at one end thereof, the tube having an inlet delivering in a rotary direction to the space about the pipe and having a converging particle discharge passage at the opposite end of the tube, the axis of the discharge passage being inclined to the axis of the tube. (APB)


The five parts of the paper deal with: (1) Losses in suspended solids, and values in their recovery; (2) particle size, with particular reference to the increasing difficulty in recovery as the particle size decreases; (3) dust and fumes in community and individual living; (4) means and procedures for dust and fume collection; and (5) description of examples of specific equipment in service and of the several types used for dust and fume collection. In the first section, copper roasters, reverberatory furnaces, copper converters, lead and zinc furnaces, iron and steel works, cement plants and power plants are considered separately as sources of dust and fume, with discussion of economic loss. The third subject is discussed rather briefly, with special attention to the difficulty of reducing dust to a maximum particle size count under present conditions. The last two sections give an extensive discussion of the various types of dust and fume removal—settling chambers, inertial or centrifugal methods, filters, scrubbers, and electrical precipitation. (IHBD)


The reasons for removing dust particles from gases are discussed, and the characteristics (motion, occurrence, means of removal) of grain sizes from 0.001-8.000 are tabulated. Choice of filter for different purposes is considered and types of filter, cyclone, "multicloon," are described and illustrated. Theory and action of electric filters is given in detail and table and parallel plate filters are described. Applications are discussed and typical installations of tar-filters in gasworks, dry and wet filters in H₂SO₃ plants, extraction of ALO₃ dust in metallurgical plants and filtering of fine gases in boiler plants are described and illustrated. (FA)


Relates to cinder and dust collectors. (APB)


Methods for removal of dust from cupola stack gases are reviewed, and the properties of emissions from the ferrous foundry cupola are discussed. (APB)


Describes the process of precipitation, types, construction, and applications of precipitators, power units, and various methods of rectification. (APB)


Claim 1: An air cleaner, comprising a main outer casing member, an inner casing member disposed within the outer member and spaced therefrom, the lower portion of each casing member being formed by downwardly converging side walls, a helical blade interposed between the members and forming a helical passage between the blades, the blade having the opposite edge portions thereof conforming to the shape of the opposite surfaces of the casing members, a tank communicating with the passage at opposite sides of the lower portion or portions of the blade, and means for maintaining a body of liquid within the tank and within the lower portion of the outer casing member at a level or levels to cause the lower portion or portions of the blade to be constantly submerged in the liquid and to form restricted spaces between the surface of the liquid and the bottom of the inner casing member, whereby air flowing through the passage will impinge against the surface. (APB)

1950


Photoelectric smoke-density indicating equipment, designed to indicate or record continuously smoke or haze from a boiler furnace, is described.

In some designs relays sound the alarm and energize the signal lamps. In others, as in the two types described, these functions are performed by thyristrons (gas-filled electron tubes). The two types are discussed in detail with illustrations.


Contamination of the atmosphere and its potential adverse effect on health are causing widespread concern. Measurement of the effect of the size of airborne particulate matter is an important phase in the study of atmospheric pollution, because toxicity evaluation and methods of control are based in part, upon knowledge of particle size. Furthermore, the degree of obscuration of light during smog conditions has been shown to depend largely upon the particle size of the air contaminants.

Using commercially available apparatus, airborne particulate matter is precipitated electrostatically upon a bright-line hemacytometer with the aid of two simple fixtures which are described. The diameter of the individual particles is measured in the customary manner with a filar micrometer. The size range of atmospheric dust and in-paint dust and mist is ascertained by the precipitated method is compared with results obtained using the Owens jet dust counter, and with that of factory dust in general as reported in the literature. Advantages of method are: Density of deposits may be controlled; solution of dust and mist is avoided; and particles are precipitated in their original state. (14 refs. cited)

The important principles in the removal of particulate matter and how they are applied in some of the common commercial wet collectors are considered. The five important principles of removal that are employed singly or in combination in wet collectors are: (1) Collision (washing or sweeping of particulate matter from air stream), (2) centrifugal force or sudden directional change, (3) electrostatic attraction, (4) moisture condensation, and (5) diffusion.

The various types or models of collectors in common use are described in detail. Some of the advantages and disadvantages of wet collectors are listed. (7 refs. cited)


Techniques involving the optical and the electron microscope were used to identify particles collected from Los Angeles smog. Several well-known methods, such as thermal precipitation, impaction, and settling, were used for sampling. Charged particles were collected on charged microscope slides. The overall composition of the material collected was studied by chemical-microscopic methods. The identity of individual particles was determined by studies of the optical properties and by depositing reagents on the particles by means of micropipets controlled by a micromanipulator. Tarry materials, oily and aqueous droplets, and crystals that were mainly ammonium sulfate were collected from Los Angeles smog. Hexagonal crystals tentatively identified as fluorides were occasionally observed.

Settling techniques were particularly convenient for collecting samples to be studied with the electron microscope. Particles that appeared to have been originally droplets containing dissolved solids, and droplets of a relatively nonvolatile oil, were observed with the electron microscope. The methods described should be applicable to many studies of air pollution. (Authors’ summary)


Complaints have been made of dust and smell from a new cement works at Pagewood (Buckley) in spite of the use of an electrostatic dust remover. (APB)


Dust and mist collection is concerned with the removal or collection of liquid or solid dispersoids in gases for purposes of:

(1) Nuisance elimination—as in cleaning ventilation air or fly ash removal from power-plant combustion gases.

(2) Equipment-maintenance reduction—as in filtering engine-intake air or pyrites furnace-gas treatment before its entry to a chamber sulfuric acid system.

(3) Safety- or health-hazard elimination—as in collecting siliceous and metallic dusts around grinding and drilling equipment and in some metallurgical operations and in flour dusts from milling or bagging operations.

(4) Product-quality improvement—as in air cleaning in the production of pharmaceutical products and photographic films, and paper.

(5) Recovery of a valuable product—as in collecting dusts from driers and smelters.

(6) Powdered-product collection—as in pneumatic conveying; the spray drying of milk, eggs, and soap; and the manufacture of high-purity zinc oxide and carbon black.

As a prerequisite to the design of industrial control equipment, an understanding of the fundamental properties and characteristics of gas dispersoids is necessary. Such properties as particle size, particle classification, explosion hazards, health hazards, and miscellaneous properties are considered briefly.

Atmospheric pollution measurements are discussed. The forces or mechanisms utilized for dust collection are classified as (1) gravitational, (2) inertial, (3) filtration, (4) electrostatic, (5) physiochemical, (6) thermal, and (7) sonic.

Impingement separators, cyclone separators, mechanical centrifugal separators, miscellaneous inertial separators, packed-bed separators, cloth collectors (bag filters), scrubbers, electrical precipitators, air filters, and miscellaneous collectors are described in detail, with illustrations of their design and discussion of efficiency in use. (Many refs. listed)


Brief history of the electrical precipitation of particulate matter from air. The efficiency and use of the precipitator are discussed. (39 refs. cited)


Extensive progress has been made within the last decade in the art of mechanical dust precipitation. The most noteworthy advancement has been in reducing the diameter of collecting units. Within the last 5 years, collectors using tube elements 3 inches in diameter have become an accepted economical fact, and elements as low as ½ inch have been prepared for commercial use. Several national groups are attempting to write a sample dust ordinance that can be adopted by all communities, and the present differences between the recommendations of the various organizations can be resolved to produce an enforceable emission standard. (PHEA)


A device is described which continuously collects and measures particulate electrolyte suspended in air or other gases. It consists essentially of an electrostatic precipitator, the anode of which is continuously washed by a stream of water or extremely dilute sulfuric acid. The electrical conductance of the resulting solution is measured by passing this solution through a conductivity cell. The results of this cell may be measured by Wheatstone bridge connected with some recording device. The efficiency of the apparatus for determining the concentrations of sulfuric acid in aerosol form has been described. (Authors’ summary)


Self-contained collectors are relatively small dust-collecting layouts, where dust is separated and deposed at a point fairly close to its point of origin. Among the features discussed are their applicability to different types of dusts, the use of water, cloth-type filters, cyclone separators, and dry separators in pairs, special filter and cyclone applications, water-washing dust col-
CONTROL OF AIR POLLUTION


New methods for recovering dead sulfur from the atmosphere have begun to give hemispheric smog problems and have added an important source of a basic raw material. The Trail smelter in Canada produces 400,000 tons of sulfuric acid annually from sulfur dioxide gas. About 10 to 15 percent of the total sulfuric acid manufactured annually in the United States is byproduct acid recovered from sulfur gases at zinc and copper smelters.

New developments in recovery of sulfur from the air, annual wasteage from industrial plants, and damage caused by emission of sulfur are discussed.


Dusts are defined as minute solid particles released into the air by natural forces or by mechanical processes such as crushing, grinding, milling, drilling, demolding, shoveling, conveying, bagging, and sweeping, and fumes as minute solid particles generated by the combustion of solid matter after volatilization from the molten state, or may be generated by sublimation, distillation, calcination or chemical reactions, when these processes create airborne particles. Regulations of the Los Angeles County Air Pollution Control District limit dusting to a 1-hour period within the process cycle; hence, extreme care must be taken in cleaning the testing equipment to avoid error with the small samples collected. Except for very high stock temperatures, the impinger method is used for stack analyses of dust loading, if the recovered dust is wettable. The standard impinger method and modifications are described. Where the dust is not wettable, a glass sampling tube, connected directly to a glass thimble holder, has been used successfully. The standard stainless-steel sampling tube with extra tapered nozzles of different diameters for selective meter rates, and a metallic thimble holder are standard equipment for use at high temperatures. When necessary, an extra length of stainless-steel tubing surrounded by a water jacket is used to prevent thimble charring. Methods of determining the gas velocity and volume are discussed. (PHEA)


In investigations on aerosol properties it was found convenient to use monodisperse aerosols, as a single parameter (the droplet radius) is sufficient to define their physical properties. A diagram of a working model of monodisperse aerosol generator is given. In early experiments the optical properties of aerosols were calibrated empirically, but later they were checked with predictions of the Mie theory of light scattering. Several conclusions on optical obscuration by monodispersed solid particles are presented. The filtration efficiency of aerosols as a function of particle size and nature of filter was determined, for which a sensitive forward angle Tyndallometer was developed. The advantages and disadvantages of a cascade impactor for detecting particle-size distribution are discussed.


This article deals with the various phases of dust and mist collection, such as purpose, properties of particle dispersoids, particle measurements, particle dynamics, and collection equipment.

Under collection equipment, impingement separators, cyclone separators, mechanical centrifugal separators, scrubbers, electrical precipitators, air filters, and miscellaneous collectors are discussed in detail. (Numerous refs. are listed at the beginning of the section and throughout the text.)


An instrument is described for precipitating aerosols which utilizes the principle that particles in an air stream drawn past a hot wire will collect on nearby cool surfaces. To avoid difficulties in counting caused by size segregation, the sample collector is oscillated to achieve random distribution of the particles. The apparatus is illustrated, and electron micrographs of representative fumes and mists are shown.


Available information on sampling atmospheric impurities by filter-paper methods has indicated that numerous intimately related variables affect efficiency of collection. These include such factors as the type of paper, sampling velocity, relative humidity, particle size, and physical properties of the contaminant and possible atmospheric concentrations.

To elucidate this problem, studies using a filter-paper sampling train, followed by a flame photometer, were made to evaluate end losses. The studies thus far have been limited to the effects of sampling velocity and concentration on the efficiency of Whatman No. 41 filter paper.

The mean results show a rapid increase in efficiency with increase in sampling rate from 7.2 cm. per sec. up to 36 cm. per sec., efficiencies of 73.3 and 94.5 percent being found, respectively. With further increase in sampling velocities, the efficiency increased more slowly, gradually approaching 100 percent, with the highest recorded value being 99.6 percent at 142.4 cm. per sec.


A separator for separating solid particles of a magnitude down to 10μ (a at a volumetric weight of 1 gm./cm.4 suspended in a particle-laden gas current. (APB)


Following a description of the various types of dust separators and collectors, their advantages and disadvantages are reviewed, with particular reference to the physical characteristics of fly ash. The application and efficiency of mechanical collectors and electrostatic precipitators, separately and in series, are discussed. (APB)


The purpose of this paper is to acquaint small-plant owners and management burning coal with fly ash problems developing due to legislative or more stringent dust codes. Trend indicates, in many cases, previously accepted methods of controlling fly-ash emission may no longer prove adequate. To meet this problem, a review of various types of dust collectors with the advantages of each relative to dust ordinances are discussed. (APB)


Much has been done to mitigate atmospheric pollution by improvements in design and operation of boil-
ers, furnaces, and stokers. Further improvements will be definitely limited. Some sort of collecting equipment is necessary for a total control when solid fuels are burned in suspension. It is also required on many underfeed and traveling-grate stokers, especially at the higher burning rates. (APB)


An examination of high-efficiency cyclones, instanced by Davidson type D collectors in soap works, and electrostatic precipitation are discussed, with a short description of the precipitator filter. (APB)


Second survey of dust collectors describes a mechanical removal method, using a cone with laminated steel dust separators, electrostatic precipitation, combined mechanical and electrostatic collectors, and gas scrubbers. (APB)


The principles involved and the instruments and methods for the removal of suspended particles in gases by electrostatic precipitation and sonic flocculation are discussed. A brief history of the former method is presented. Electrostatic precipitation for use with industrial gases and smoke and for air conditioning and air cleaning are described and discussed.

The more recent method of agglomeration of suspended particles in smoke and fume by sonic flocculation is discussed with special reference to the types of instruments used and the theories involved. In conclusion it is stated that there is still much work to be done on this method. (PHEA)


The present trend in pulverized-coal-fired boiler combustion-gas cleaning is toward virtually perfect stacks at all times, or at least the maximum removal of fly ash obtainable. An efficiency of 97 to 98 percent is often requested, but efficiencies above 98 percent involve complex problems in application. Practical solutions now exist for most of these problems. It is not uncommon for all sections of a precipitator to be controlled by a single instrument. A meter is connected to one boiler outlet to the next. The more difficult problems have to do with variations in ash characteristics, particularly its resistivity and stratification at the precipitator outlet. Several methods now in progress or recently applied for combating those conditions include: (1) Continuous rapping of electrodes at controlled intensity; (2) automatic voltage control; (3) the pulse method of energizing; (4) combinations collectors comprising centrifugal separators preceding precipitators; and (5) conditioning of the ash to maintain its resistivity below the critical value of $2 \times 10^9$ ohm-cm., by increasing artificially the trace amounts of sulfur trioxide naturally present in boiler combustion gases. Further developments may be expected along the lines of more uniform performance and maintenance of the necessary continuously high efficiencies. (PHEA)


Claim 1: A cyclone separator for removing dust from gas of the kind, comprising a dust-separating chamber and a gas-discharge chamber or compartment. Material is discharged by gravity and a gas-discharge pipe between them wherein an externally operated valve is provided for closing the gas-discharge pipe as it issues into the gas-discharge chamber of the compartment. (APB)


Interim report on the subject, the preliminary report having been presented. A drawing of the equipment being used, which shows the unit, has been simplified and the complexity minimized.

The average plant has not been constructed to meet the requirements of an ideal location for sampling the effluent gases. It may be necessary to have stacks or breechings built so that a testing area is incorporated that has the necessary requirements outlined by the American Society of Mechanical Engineers and the American Society for Testing Materials.


The electric precipitator is widely used for collecting atmospheric samples of dust and fume and has proved to be dependable for field use.

A project was undertaken to design a different type of power supply. The new power supply uses radio frequency. It weighs only 2 3/4 pounds, and the cost is reasonable.

Laboratory tests showed collection efficiencies comparable to those of other instruments now in use. Lead and zinc oxide fume and a residue dust from a chromate plant were used for these tests. A limited number of tests showed the essential difference in collection efficiency when the polarity was reversed.

The instrument has not been subjected to field tests but was operated in the laboratory over 150 hours, including 8 hours a day for 4 consecutive days. There was no indication of any breakdown of parts during this time.


The analysis of contaminated atmospheres is often complicated by the low concentrations involved. However, cold surfaces can often be used to concentrate volatile materials. The sampling of volatile atmospheric contaminants by cold-trap techniques was studied to determine the efficiency of such methods and to develop improved equipment. Formaldehyde at concentrations in air that are a fraction of a part per million was collected with about 80-percent efficiency at liquid-nitrogen temperatures by using metal packing in the traps. Without packing, only 50-percent efficiency was achieved. Similar results were obtained with low concentrations of benzene and sulfur dioxide. A convenient cold-trap system was developed, consisting of a dry-ice-cooled coil followed by a liquid nitrogen-cooled metal-packed U-tube. The results of this work have been very helpful in studying the composition of smog in Los Angeles County and should be applicable to many air-pollution problems.


A system has been developed for eradicating all visible smoke and fume and collecting large quantities of light, gray, fine, powdery substance in industrial machine hoppers below the bags. Such material, when emitted to the atmosphere, is too fine to settle out and forms part of the smog blanket that overhangs the communities in the vicinity of manufacturing plants. It is claimed that this bag-type collector handles the situation satisfactorily.
CONTROL OF AIR POLLUTION

This suppressor is not restricted to cupolas. It can be applied to other troublesome dust and fume problems. It should be of interest to operators of metallurgical plants, chemical-processing plants, and other types of manufacturing activity where dust emission is a public nuisance.


Shell Chemical announces that it will install a unit to recover sulfur from waste refinery gases at Houston. Operation is expected by mid-1952. In the recovery process the waste gases, containing hydrogen sulfide, carbon dioxide, and a small percentage of light hydrocarbons, will be burned and catalytically converted to sulfur at an annual rate exceeding 13,000 tons. The product will be sold for conversion to sulfuric acid. Shell Chemical's installation will not only conserve a strategic raw material but will also help to eliminate the serious problem of atmospheric pollution in the heavily industrialized Houston area.


An air cleaner comprising a centrifugal separator of the cyclone type.


The impact method for collecting air particles is suitable for sizes down to about the limit that can be handled satisfactorily under the optical microscope. This method, with some chemical techniques that appear capable of giving much information about the material collected, is described. Application of these techniques to study of metallic meteoritic material in the atmosphere and air movement on a meteorological scale is mentioned.


The collection efficiency of a laboratory model was investigated with oil droplets of three different sizes and three different methods of water injection. Collection efficiency was greater with the larger particle sizes, and it increased as concentration decreased. Collection efficiency was substantially higher with radial water injection than with axial injection. Pressure drop across the venturi increased with increased water rate and was highest with radial inward injection, and intermediate with axial and radial outward injection. In the high-collection range (greater than 90 percent) efficiency is proportional to pressure drop, and, within limits, equivalent results may be obtained by decreasing venturi throat velocity and increasing water rate, or vice versa. Included are representative data on field performance with full-scale collectors and aerosols containing sulfuric acid mist, silicon dioxide fume, iron oxide, etc. Efficiencies ranged from 52.4 percent with SiO2 fume to greater than 99.9 percent with H2SO4 mist.


Holt describes the photoelectric methods of obtaining instantaneous readings, which are a measure of the dustiness of the atmosphere. The application for the collection of large samples for fundamental research purposes is also described. (AIHOM)


Air-pollution control boards would have only a minor problem in preventing the escape of solids from industrial process stacks if exhaust air or gas were at normal temperatures. Collection equipment is available at reasonable cost and will provide the required degree of solids removal for virtually every dust problem where higher than room temperatures are not encountered.

On the other hand, in applications where hot and often moist gases containing considerable quantities of solids are discharged to the atmosphere, effective collection equipment has not been as generally provided, owing to the expense and difficulties involved. Various types of collection equipment are described and illustrated.

The regulation of gas cleanliness, using a visibility yardstick, fails miserably when attempted against a background of industrial emissions. Difference in particle size, color, discharge velocity, presence of different materials, and the possibility of water vapor make visual determination of solids concentration an unreal and an impractical method. Emission densities from such problems are not an indication of poor process control and has no parallel with the use of Ringelmann charts as a gage of combustion control in boiler practice. Until cleaning equipment becomes available at reasonable cost and reasonable maintenance that will remove all visible solids, measuring of collection effectiveness in terms of weight units offers the only practical means available today for defining the effectiveness of control measures.


In a sonic agglomeration aerosols—dusts, smoke, fumes, fogs, or mists—are subjected to high-intensity sound. This sound causes the gasborne pollutants to vibrate, collide, and adhere together in clusters large enough for removal from the gas phase in a secondary separator, such as a cyclone. The method is described in detail.

By the use of high enough power input or long enough contact time in the agglomerator, almost any desired degree of pollutant agglomeration can be obtained. The optimum combination of sound intensity and contact time can be determined only by an economic study based upon adequate data on optimum frequency, pollutant concentration, and ease of agglomeration. Then the sonic agglomeration and collection system must, in turn, be compared on an engineering and economic basis to other systems for removing pollutants. It is believed, however, that many new and varied applications of sonic agglomeration will be brought forward in the near future. (6 refs. cited)


The use of existing types of dust- and mist-collection equipment is explained and the factors that must be considered in the design and operation of such equipment are summarized. Various types are described. Dust- and mist-collection equipment is required to collect a powdered product; to recover a valuable product; to eliminate a nuisance; to reduce equipment maintenance; to eliminate a health, fire, explosion, or safety hazard; to improve product quality, as in air cleaning in the production of pharmaceutical products and photographic film. (11 refs. cited)


The factors that enter into the design and operation of gravity settling chambers, inertial separators, packed beds, and scrubbers are summarized. A table is included giving a classification of dust collection equipment based on structural and application similarities.

Except for scrubbers, the equipment described is applicable only to the collection of particulate pol-
lutants, such as dust or mists, and not for the collection of gaseous pollutants. (8 refs. cited)


Very detailed discussion of French, Belgian, and Netherlands existing and draft regulations on dust content and sizes in industrial smoke. Erection and efficiency of electrostatic precipitator in terms of dust and ash content. A numerical value of the soot recombination. Combination cyclone-electrofilter.


A series of simple field experiments in testing bag type dust collector fabric for pressure drop and dust retention is described. Several illustrations accompanying the article show the locations of the fabric holder, strip heater, manometers, and dirt trap. It is suggested that these experiments were successful enough that the principles involved should be widely applicable, particularly in comparing dissimilar fabrics. (IHHA)


A major step toward smoke control is installation of two gas washers and a companion setup of electrostatic precipitators for cleaning gas from the furnaces for use in new high-pressure boiler plant at National works of United States Steel's National Tube Co. at McKeesport, Pa. A second antismoke development is installation of dust collectors that virtually eliminate fly ash from the boiler stacks when coal is used instead of blast-furnace gas.


Describes briefly the first iron foundry dust suppressor to get the Los Angeles smog control board's O.K.

It removes all gases and over 95 percent of the solid particles given off by two cupolas. The unit is not limited to foundries; it can put an end to nuisances of dust of many types.


It is stated that the voltage drop across the layer of collected dust on the large electrodes of the ionizer may be high enough to cause electrical breakdown through the layer. A glow at these points of breakdown results in partial neutralization of the charge acquired by the suspended dust particles and hence a loss in cleaning efficiency. Other troubles are wire vibration and increased generation of ozone. Operation at higher relative humidity or the liberal use of adhesives are claimed to reduce these effects.


The impaction of small particles on cylindrical and spherical collectors has been analyzed in terms of the forces that affect the motion of a particle and cause it to move from an aerosol stream onto a collecting surface. Dimensionless parameters that characterize the various mechanisms of collection are defined for inertial separation, interception, electrical attraction by charges, electrical attraction by induction, settling, and random molecular motion. Significant values of the parameters have been determined. The various theories of impaction of aerosol particles on simple collectors have been investigated and extended to a comprehensive statement of the general problem of

Impaction efficiencies. Practical applications to dust- and smoke-removal systems are indicated. An appendix to this report contains English translations of two important references on the filtration of dust and smoke from air streams. (AIHOM)


The application of electrostatic precipitation equipment to problems involving the reduction of atmospheric pollution is considered. Different methods are used, together with a description of the basic considerations in electrostatic precipitation, are summarized briefly.


The general principles of operation and design of Cottrell precipitators are given. These precipitators are compared to other collecting apparatus, such as cyclones, baghouses, scrubbers, and ultrasonic agglomeration. The Cottrell is comparatively versatile, being used for the collection of such diverse materials as tobacco smoke and up to 100 tons of fly ash or cement dust per day. The ordinary temperatures may range up to 700° F, although some dry dusts may present difficulties in the range of 200°-270° F. (4 refs. cited)


High and low temperatures are better for electrostatic-precipitation operation than intermediate temperatures around 200°-300° F. When the resistivity of the collected dust layer exceeds 1010 ohms per 1 cm², arcing and "back discharge" will occur and result in abnormal power consumption and serious loss in dust-collecting efficiency. Below 300° F, increases in moisture content and decreases in temperature result in lower resistivity of the dust layer through greater adsorption of water molecules, which render the surface conductive. Above 600° F, the effect of moisture is negligible, and current is conducted through the interior of the particles by either electronic or ionic processes.

Aside from the effect on dust resistivity, increased moisture in the conveying air streams tends to quench the corona discharge and increase sparking potential, while increased temperature has the opposite effect. (IHOM)


In the collection of airborne pollutants by adsorption, the polluted air is passed through a granular bed of solid adsorbent. The pollutants are removed by physical or chemical adsorption on the surface of the adsorbent. When the adsorbent has become saturated, it is removed, reactivated, and replaced.

Activated carbon is the preferred adsorbent for removing gaseous pollutants, for the following reasons:

1. Suitably activated carbon has a high retentive capacity for gases and vapors. This "retentivity" is defined as the maximum weight of adsorbed pollutants retained by the carbon on exposure to the ambient air, and represents the practical capacity of the sorbent. For most air-pollution applications, activated carbon will retain at least 15 to 20 percent of its weight of pollutants. Table I lists the retentivities of some representative gaseous or vaporous pollutions.

2. Activated carbon, unlike oxygenated sorbents such as silica gel or activated alumina, is nonpolar. Therefore, it has no retentivity for water vapor. Thus the presence of moisture in the polluted air in no way
affects the effectiveness of efficiency of the purification process.

The specifications of a gas-adsorption carbon suitable for air purifications are listed.

Equipment and engineering for the application of activated carbon to air purification must combine efficient removal of the pollutants for a reasonably extended time, with low resistance to air flow. This requires an adequate amount of granular carbon arranged in thin beds, coupled. (3 refs. cited)


The problem of collecting airborne solid pollutants at the point of their production is one that industry knows primarily as "dust control." Obviously, much more can be accomplished in elimination of public nuisance by preventing the discharge of aerosols from an industrial site, than by trying to cope with them after they are on the loose. This means that the control of smoke and dust is a more useful method than the filtration of incoming air.

Of the many methods used for dust control, filtration is the one most widely applied to the collection of particulate matter in the size range from 50a diameter down. This discussion deals solely with such methods. (4 refs. cited)


An account of the experimental and theoretical work done during the past 25 years on the particle-charging process. Some new experimental results are given, and the present state of development of the particle-charging art is discussed. Reference is made to several disturbing effects that may adversely affect particle charging under practical electrostatic precipitation conditions.

1952


A newly proved type of smoke-control equipment, costing $200,000, is being installed in the Consolidated Edison Co. Hell Gate electric generating station in the Bronx. It incorporates an entirely new idea in the technique of dust control and has been available in the United States only since 1949. The Hell Gate unit is the largest ever built and will be the first in New York or any of its neighboring States.

The collector consists of 64 hollow-steel cones, each more than 10 feet high. These cones are installed so that gases emerging from the boiler will enter the large end of the cones and emerge through some 2,000 slotted perforations in the sides.

The gas stream must change direction sharply to pass through the slots. It has been found that dust and ash particles are in many instances too heavy to make the sharp turn with the gas. These solid particles therefore continue through the cone to the narrow end, where they are separated from the gas and removed by the station vacuum ash-collecting system.

Some particles are small enough to escape through the slots. These must pass through the electrostatic precipitator before reaching the stack.

The new device is called an Aerodynamic. An experimental unit was purchased by Con. Edison in 1950 and found to be efficient. The decision then was made to install regular units in the Hell Gate station.


Review of a book, entitled "Cottrell: Samarian of Science." In addition to the many scientific ideas Cottrell gave away, his own work consisted mainly of perfecting electrical precipitation of smoke, dust, and fumes and recovering valuable materials from them.

A summary of Cottrell's work at the time he was presented the Perkins award follows:

"Not alone has he taken the sting out of sulfuric-ac.1 waste fumes of smelters, he has brought down poisonous arsenic, saved molten dust otherwise going to waste, saved the orange groves from cement-kiln smoke, and recovered potash from the cement smoke to put on those very orange groves for fertilizer. The dust in the air which was death to the trees through the clogging of the tender pores of their leaves, when duly Cottrellized and sacked and emptied on their roots, has given them new strength and life."


The air-pollution problem in Los Angeles is reviewed, and the steps taken by specific metallurgical and mineral industries to determine the nature and amount of dust and fume produced and the methods used to control their emissions at the source are discussed. The nonferrous pyrometallurgical industries, the ferrous pyrometallurgical industries, and the industrial mineral dusts and fumes are treated separately. The electrical precipitator and the baghouse are the most versatile and positive devices demonstrated industrially to date for accomplishing this purpose. The precipitators, large and small, operated wet or dry, are the answer to some of the most difficult problems in ferrous and light metals work and industrial mineral processing. Units as small as 10,000 c. f. m. are being operated satisfactorily. Particulars particularly those designed and equipped for operation at high temperature (250° to 500° F.), are producing excellent results in both ferrous and nonferrous work at costs that most industries can afford. (AIIHOM)


Claim 1: A cyclone separator for separating fine divided solid particles from gaseous fluids comprising an outer casing of circular cross section, a tangential inlet in the upper portion of the casing for the introduction of the gaseous fluids containing the solid particles, an outlet tube coaxially disposed within the casing extending downwardly from the lower part of the inner cylindrical shell terminating at a level below the tangential inlet and the lower end of the inner cylindrical shell terminating at about the lower end of the outlet tube, a plurality of spaced conduit members attached to the lower end of the inner cylindrical shell extending downwardly into the lower part of the cyclone separator, the inner cylindrical shell dividing the stream of gaseous fluids containing solids into two parts, one part flowing spirally downward between the inner shell and the casing and thence between the spaced conduit members to the outlet tube and the other part flowing spirally downward through the annular passageway between the inner shell and the outlet tube, nozzle means arranged adjacent the upper end of the annular passageway and the inner cylindrical shell positioned to discharge a stream of fluid at high velocity tangentially into the inner shell to increase the rotational velocity of the gaseous stream passing through the annular passageway between the inner cylindrical shell and the outlet tube, and an outlet in the bottom of the outer casing for the withdrawal of separated solid particles. (AIPB)

The theory of electrostatic precipitation indicates that it is a method of removing particulate matter from an air stream with high efficiency for even very small particles. The rate of deposition is a function of particle size. Both a-c. and d-c. precipitation can be used for sampling the particulate matter.

The following two units, which can operate at efficiencies of approximately 99 percent by weight, are described: (1) A commercially available d-c. electrostatic sampler and (2) a-c. samplers—usually homemade.

These samplers are useful for sampling atmospheric dusts, fumes, and mists for determination of total weight concentration or for chemical, spectrophotographic, or radioactivity analysis. Depending upon the characteristics of the dust, they may be used where dust costs are to be made.

Using the electrostatic principle, a dust count can be made wherein the dust is deposited directly on a microscope slide. A portable sampler for handling 125 c. f. m. has been made for collecting larger samples of atmospheric particulate matter.


Owing to the ever-increasing importance of reducing the quantity of solid particles discharged into the atmosphere from smokestacks everywhere in this country, it has become increasingly necessary in many locations to install modern dust-collector equipment.

This is particularly true in Washington, D. C., which, aside from being the Capital of the Nation, is inherently an unusually clean city owing to its lack of heavy industry.

For this reason, the city of Washington is very conscious of any smoke or dust nuisance; in fact, one of the provisions of the local smoke ordinance is essentially that any solid or gaseous discharge constituting a nuisance is unlawful.

Therefore, the Potomac Electric Power Co., which serves the District of Columbia and adjacent areas in Maryland and Virginia constituting the metropolitan area of greater Washington, has found it necessary to install in its steam-generating stations the most efficient and reliable dust-collector equipment available.

The factual data indicate the results to be obtained from highly efficient series dust-collector installations and the capital expenditures necessary to provide these facilities. The operating and maintenance costs of these facilities at two typical pulverized-coal-fired generating stations are outlined.


Simultaneous dust-extraction tests have established that: (1) Fairly good correlation exists between the midget impinger and the Soxhlet dye; (2) correlation between the thermal precipitator and Soxhlet dye is only fair, especially for fine airborne dusts; (3) ratio of midget-impinger results to thermal-precipitator results is about 2:1 for purely carbonaceous dusts but varies widely for others; (4) in view of the many errors that enter into the calculation, it is desirable to decrease the number of extractions if the difficulties of examination do not rapidly limit their number. (APB)


The operation, advantages, and disadvantages of the five main types of dust collectors are considered, namely, settling chambers, cyclonic type, centrifugal and impingement, to which may be added gas washers, filters, electrostatic precipitators, and centrifugal or cyclonic collectors. (APB)


The basic principles involved in the design of inertial and motor-powered dust separators are considered. Design equations relating to the behavior of dust particles in an air stream and their influence on collector efficiencies are given in detail. A discussion of the applications and limitations of dry-type dynamic separators forms an important part of the paper.


The invention comprises an electrostatic precipitator which includes special rapping or shaking mechanisms for dislodging the accumulated dust from the electrode plates. (APB)


Field tests of air-cleaning devices indicate the range of usefulness of several types of commercial dust-collection equipment now available to industry.

Proper selection and application of dust-collection equipment depends upon a knowledge of performance: Capacity, power requirements, and overall dust-retention characteristics. The concentration and size distribution of the collector effluent, in relation to the many possible variations in industrial dust loads, are particularly significant. Available information is limited primarily to manufacturers' data or to tests that supply only a partial correlation between nature of the aerosol and performance.

A field investigation of common types of commercial air-cleaning equipment was undertaken by the Air Cleaning Laboratory, of Harvard University, to expand knowledge of collector performance. This report deals with the results of field tests on filter and inertial-type collectors. (6 refs. cited)


The question of dust carryover from power-station chimneys is reviewed. Work on the arresting and collection of dust by washing, centrifugal collectors, and electrostatic precipitation is discussed briefly. (APB)


Account of an experimental program, instigated by the British Standards Institution and carried out at the Fuel Research Station, on a model flue. Its aim is to develop a method for obtaining a representative fly-gas sample at a single point, instead of the previous minimum of 24 points. (APB)


Anheuser-Busch Brewery, St. Louis, Mo., operates one of the largest power-generating plants in the food industry. When a St. Louis ordinance designed to control air pollution was passed in 1949, Anheuser-Busch installed mechanical separators to reduce emission of fly ash. A new ordinance was passed in 1950,
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further reducing the amount of fly ash that could be emitted. To comply with the new ordinance, the brewery has installed electrostatic precipitators on its boilers, with very satisfactory results. A complete description, including design of the equipment, appears in the article. (PHEA)


A discussion of the relative merits of sedimentation, electrostatic precipitation, and centrifugal collection for removing dust. (APB)


Dust precipitation by gas washing, centrifugal collectors, and electrostatic precipitation is described. Methods of testing the performance of equipment are discussed. (FA)


Steam soot blowers are arranged to blow accumulated dust in the flues to the front of the bottom flue, from which it is removed either by hand or the use of special dumpers or in large plants by suction to a cyclone separator. (APB)


Claim 1: A whirling dust separator in which the gas to be purified is led in a tangential direction into a vertical cylinder and the purified gas is led upward through a vertical tube while the separated dust is led downward into a conical outlet connection of the separator, characterized in that underneath the tangential inlet a distributing wheel is provided, which consists of a double conical ring on the conical surface of which is a plurality of lenticular bladed. (APB)


Theories of operation are outlined briefly. High collection efficiencies are reported on aerosols down to about 0.2 micron, with good absorption of some acid gases and odors. Tabulated operating data, particle-size information, and pictures of installations that were available are shown for typical installations.

Several instances of enhanced performance are reported when the venturi scrubber was followed by the P-A cyclic spray scrubber.


This is a semitechnical review including numerous excellent figures, charts, and tables to illustrate the size and concentration of airborne particulates, construction, and operating principles of dust-catching equipment, collector costs, and dust-removal efficiency. (AIIHOM)


The theory of operation is outlined briefly. High collection efficiencies are reported on aerosols down to about 1 micron and excellent selective absorption of some acid gases and odors. Tabulated operating data, particle-size information and pictures of installations, where available, are shown for typical installations, including: Dusts from rotary limekilns; lead compounds from reverberatory furnaces; dust of iron ore and coke from blast-furnace gas; ammonium nitrate dust from rotary driers; and fumes from superfosphate "dents"; fly ash and SO2 from boiler-flue gases from pulverized coal; and absorption of sewage odors.


The principle of operation of an electrostatic precipitator is explained and illustrated. A new development is the continuous removal of ash from the electro plate. (APB)


The construction and principles of the Precipitron and miniature Cotrell-type electrostatic precipitators are described. Measurements have been made of the efficiency of these two types of precipitators in removing chemical dust from the air. Details of the experimental method are given, and the efficiency values are compared with those obtained for a number of commercial dust filters tested under similar conditions. (FA)


Antipollution campaigns and a desire to recover valuable material that had been discarded have emphasized the problem of collection. A sonic agglomerator appears promising for collecting small particles.

A collection system, employing sonic generators in conjunction with a secondary collector, is described. The collection system, as a whole and an evaluation of the important characteristics of each component are discussed.


In an air stream certain plastics, resins, and waxes develop a sufficient electrostatic charge to attract and retain dust, smoke, etc. Prepared in suitable forms, they provide effective, self-charging electrical precipitators. (FA)


Research to develop an adequate analysis of the impactor as an instrument for assessing aerosols and to obtain experimental impaction efficiencies for rectangular and round aerosol jets impinging on flat surfaces is described.


Aerosols as they occur in the atmosphere are discussed under the classification of fogs, dusts, and smokes. These types are discussed with respect to stability as regards precipitation and coagulation, including the effect of electrical charge.

Some consideration is given to the meteorology of aerosol clouds. The optical properties of aerosols are discussed briefly.
No attempt is made to give a quantitative theory of filtration, but the general mechanism of filtration is considered under the headings of inertial effects applying to large particles and the diffusion of small particles. Although the theory indicates a size of particle that should give maximum penetration of a filter, data to support this theory are not available.

The effect of static charge on the filter material is considered, but no discussion is attempted for the filtration of aerosols that have been charged by artificial methods.


Although the problem of controlling air pollution caused by corrosive air pollutants has attracted more attention recently, it actually has been studied for many years. Forty-two years ago, the American Smelting & Refining Co. at Selby, Calif., installed the first satisfactory commercial electrostatic precipitator to suppress acid mists produced during gold and silver parting operations. Converting waste sulfur dioxide gases has been an important source of sulfuric acid for more than half a century, and in the last 5 years some 20-25 chemical plants have spent $19,000,000 on added facilities to control air pollution alone and pay a bill of $5,000,000 a year to operate them.

Because the air-pollution problem is not new, industry has had ample time to develop and perfect appropriate controlling equipment. The approach to the control of corrosive air pollutants has followed two general courses of attack, depending on whether the effluent is an aerosol or a gas.

In controlling pollution of air by an aerosol, such as sulfuric-acid mist, the problem is simply one of collection. If the particles that are small enough to float in air can be coalesced or agglomerated into larger particles, they can thus be prevented from polluting the air.

In controlling pollution by a gas, such as sulfur dioxide, an entirely different technique must be utilized. Two that are in commercial use are: (1) Conversion of the sulfur dioxide to sulfuric acid, provided the volume warrants the expense and (2) absorption of the gas in chemicals from which it can be recovered as pure sulfur dioxide.

In controlling pollution by hydrogen sulfide, a less corrosive but more toxic gas, the approach has been similar to that used on sulfur dioxide. One method is to burn it in air to convert it to sulfur dioxide and water vapor.

Hydrogen sulfide is now being treated in a number of oil refineries by these methods. One refinery in the Los Angeles area is producing sulfur at the rate of 500 tons per day from gases that formerly were burned and thus introduced 100 tons of sulfur dioxide into the atmosphere per day!

Various types of collection and precipitation equipment, as well as other less commercially used methods are mentioned. All those described are known to be systems in use in industry today for overcoming the problem of controlling corrosive air pollutants.


The sonic flocculator as a tool for precipitating aerosols is described. High-frequency sound may be generated continuously by (1) a vibrating body such as a rod, plate, diaphragm and (2) by a pulsating or modulated stream of air or gas.

The rate of collision and agglomeration of any aerosol is hastened many fold by intense, high-frequency sound. The rate of agglomeration is much greater for sound in a resonant enclosure than for an unobstructed progressive wave. Although a complete and quantitative theory for sonic flocculation cannot be given, such a theory must consider the effects of radiation pressure, random motion of the particles, coagulation of the suspended particles and hydrodynamic forces between the particles, probably in the order of importance named.


Some of the principal features of Cottrell precipitators and their application are presented. Attention is called to the fact that all of the problems associated with precipitation have not been solved in the course of the past 40 years, although much progress has been made.

The subjects discussed are the fundamental principles, design, application, performance, and limitations of electrostatic precipitators.


The advantages and disadvantages of dry and wet collection equipment are listed. (APB)


Claim 1: Means for removing liquid and solid-phase particulate matter from gases, comprising a plurality of centrifugal-type separators of tubular shape, each arranged in an inclined position, between which the main gas stream is divided, and inclined dust-collecting tubes, each collecting dust from some of the centrifugal-type separators and delivering it to a receiver. (APB)


Claim 1: A cyclone separator comprising a helical jacket having an inlet tube tangentially connected thereto, a closure for the upper end of jacket, a central tube in jacket opening through closure and arranged centrally with respect to the axis of the jacket, characterized in that the helical jacket forms about half a turn around the circumference reckoned from the inner part of the inlet tube and that the upper portion of the central tube connected to the closure or the end wall of the helical jacket is provided with a conical funnel such that the space between the jacket and the funnel decreases toward the closure and further characterized in that two or more annular elements are arranged as parts of a virtual wall member, at least at the lower orifice of the outlet tube and at the transition between the conical tube and a cylindrical part of the jacket, and that the elements are so arranged in this tube that one or more free annular spaces are formed below and between elements so that cleansed air can be drawn off toward the central tube in order to separate it from the rotating mixture of air and dust. (APB)


Claim 2: An electrofilter characterized in that the emission electrodes are composed of wires coiled to screw shape, which wires by stretching have been given a slightly wavy shape and which are fastened in rows in the frame hooks or the like arranged in pairs and right in front of each other, and that the precipitating electrodes are composed of plates arranged between the rows mentioned. (APB)
2902. Thelen, E., and Muchnick, S. N. Freezeout Apparatus for Collection of Air Contaminants. Jour. Env. Eng. Div., Proc., vol. 88, 1962, pp. 183-200. Describes apparatus designed to permit the entrapment of analyzable quantities of atmospheric contaminants in a relatively brief period of time. Thermal-efficiency tests indicate the equipment is capable of cooling as much as 2.3 c. f. m. to 0-180° C. Photograph of apparatus is included. (APB)


Operation of coal-burning central stations to conform to present-day ordinances presents problems. Methods of handling these problems are discussed. Properly installed collectors provide a means of reducing ash discharge. The program of installation must be carefully coordinated with necessary maintenance to preserve proper reserve capacity.


In the Los Angeles area air-pollution regulations require that most industries recover 85 to 93 percent of the smoke particles matter being emitted to the atmosphere. Of 58 gray-iron foundries, 15 have abandoned cupola melting and are now using reverberatory furnaces, and one is using an electric furnace. The majority of the rest are installing bag collectors preceded by gas coolers. Wet scrubbers and washers and centrifugal devices were not found satisfactory for this service. Collector costs averaged $1,625 per ton process weight per day.

The coffee-roasting industry has eliminated its problem by installing secondary burning equipment to raise the temperature of effluent gases to a point where all carbonaceous and odoriferous matter is burned. The fish-processing industry, which had been a tremendous odor problem, corrected its condition by better process control. The nonferrous foundry industry is adopting bag collectors, and steel plants are using electrostatic precipitators. Sulfur dioxide has been reduced to one-fifth of its former value by the installation of absorption equipment.

Certain hydrocarbons (particularly, unsaturated hydrocarbons), in the presence of sunlight and finely divided dust particles, are converted to aldehydes, peroxides, organic acids, and other constituents that produce noxious effects.

A million backyard incinerators contribute daily some 90 tons of aerosols and a like quantity of aldehydes, oxides of nitrogen, and organic acids. (AIHOM)


Combination analyzer and recorder provides continuous record as evidence of precipitator efficiency.

Many communities recently have realized the physical damage and impaired morale caused by air pollution and have passed ordinances, some quite stringent, to force control. Some plants have taken steps themselves, motivated by a new sense of public responsibility and community spirit or by a realization that the great bulk of the dust being lost constituted their own valuable products. In these latter instances, it often has been found that the value of the recovered product rapidly paid for the expenditure on collecting equipment and at the same time improved community relations.

Many types of equipment for collecting dust are available: (1) Water devices, (2) centrifugal, (3) electrical, (4) velocity reducing, (5) fabric, and (6) combinations of the above five. All types are in use in various sizes, the type used depending on the size and consistency of the particles, the concentration of dust in the unfiltered air, and the required purity of the filtered air. Regardless of the type collector in use, a record of its efficiency and an assurance of its continuing operation are very valuable. A device, known as the General Power Plant dust recorder, is available for continuously monitoring the amount of dust in the filtered air leaving the precipitators or collectors and for signaling plant personnel when the amount exceeds a preset limit.

The equipment consists of an analyzer, which should be placed as closely as possible to the point at which the sample is taken, and a recorder, which may be placed at any convenient point in the plant, such as near the dust-collector controls or in a central control room.

The analyzer is described and illustrated.


Equipment for general ventilation and local exhaust ventilation is discussed. Electrostatic precipitators, fabric collectors, wet collectors, centrifugal collectors, settling chambers, and sonic agglomerators are described. The establishment of limits for contaminants is essential for progress in development of air-cleaning equipment. (APB)


A header provided with a number of spray nozzles and filled with a suitable liquid (water or oil) is moved continuously back and forth between the collector plates of the precipitator. This removes the dust and obviates the need for shaking or vibrating installations. (APB)


Various aspects of the electrostatic process of cleaning smoke-laden air are discussed, emphasis being placed on the part played by the corona discharge. (FA)


The utilization of condensation phenomena, although not the answer to the dust problem in its entirety, is valuable in many ways. Any major improvement in dust-removal equipment probably will utilize the condensation technique in one manner or another.

Two methods of inducing condensation are described—"thermal condensation" and "conversion condensation."

FILTERS

1980


Describes device in which smoke is washed by forced contact with water. (MIR-Bib.)


Describes Elliott smoke annihilator. (MIR-Bib.)

1895

1894. **Engineering.** Patterson's Suction Draught and Smoke-Preventing Apparatus. Vol. 69, 1895, p. 752. Essential feature is the introduction through the fan center of a jet of water, which is sprayed out among the vanes, thus keeping the fan cool and cleansing gases. Gives details of test by Professor Archibald Burt. (MIR—Bib.)

1897

1895. **Engineering Record.** Interesting Smoke-Washing Device. Vol. 35, 1897, p. 210. Installed principally to prevent the issue of fine white powder (evidently coal ash) from the chimneys. Waste gases are mingled three times with falling water, and all soot and fine ashes are removed. (MIR—Bib.)

1898


1900

1897. **Scientific American Supplement.** Apparatus for Filtering Air and Smoke. Vol. 49, 1900, p. 20371. Filter especially designed for use on locomotive stacks and for filtering air entering apartments. Air passes through spray formed by jets of steam or water striking blades of a revolving screw. (MIR—Bib.)

1901


1903

1901. **Scientific American Supplement.** Smoke-Washing Apparatus. Vol. 56, 1903, p. 23112. Describes Magua's apparatus, in which smoke is washed by intimate contact with flowing water. (MIR—Bib.)

1905


1923. Washing the escaping gases with a water spray was found to be effective. Concludes that treating fuel with lime water has no effect on sulfur acids produced. (MIR—Bib.)


1910


Successful operation has been attained by neutralizing all gases with zinc oxide and filtering the cooled mixture through bags. (MIR—Bib.)


Series of experiments on a large scale as regards the quantity of smoke handled. (MIR—Bib.)


Deposition of dust demands reduced velocity; deposition from fumes is matter of low temperature. Introduction of outside air into fumes is considered inadvisable. (MIR—Bib.)

1911


The smoke washer is a brick-lined chamber in which the gases come in contact with a spray of cold water. A steel chimney shown in drawings was changed to one of wood to avoid trouble from sulphuric acid. (MIR—Bib.)

1929


Methods of removing dust from air are summarized briefly. Observations are quoted that indicate that dust may be present in the air in the following quantities, approximating:

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<th>Country</th>
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(1) Filters to remove ordinary-size particles may be:

(a) Dry cloth—effective when air velocity is under 20 ft. per minute. (b) Water spray—effective up to velocity of 500 ft. per minute, when it removes 95 percent of other dust but only 70 percent of soot. (c) Oil film, on a metal mesh in cells like boxes of honeycomb, removes 98 percent of dust, which adheres as air percolates through and is removed by taking out one cell at a time and washing it in hot soda solution, after which the cell is relined with oil and replaced. It does not remove fog unless air is dried to drive off water filming each dust speck. (d) Water spray and oil films may be combined so that the spray removes fog and the film removes soot.

(2) Methods for removing very fine industrial dusts and smoke:

(a) Cyclone separators are useful only for large, heavy particles. (b) Settling chambers remove heavy particles over 0.1 mm. diameter if the velocity be under 10 ft. per second. Particles of less than 10 microns will not settle under any commercial conditions. (c) Textile-bag filters deal effectively with fine dust and some smoke. They are cleaned by automatic beating while the air current is reversed to flow from outside the bag in. The cleaning air current may be warm if the dust is damp and adhesive.

(d) Electrostatic means are based upon the fact that dust particles readily take an electric charge (hence explosions of coal-dust, starch, etc.). As the air passes between electrodes charged at 30,000 to 50,000 volts the dust particles settle upon the positive electrode—which is a reinforced concrete slab set on the slope so that the dust slides off as it accumulates. For general use, the textile-bag filter is recommended provided it is fitted with the automatic, self-scavenging device. (EH)

1929

1927. **Mechanical Handling.** Standard Round Filter. Vol. 23, 1928, pp. 275–275. Dust filtration is dealt with in general. The round filter, which embodies special features, is described.
CONTROL OF AIR POLLUTION 323


Presents results of research sponsored by the American Society of Heating and Ventilating Engineers in cooperation with the engineering experimentation station of the University of Minnesota. The laboratory test procedures and precautions in air filters are discussed. Air velocity as an important factor in the testing is explained and clarified. The object of the article is to present to the reader a uniform method for testing and rating any type of air filter used in general ventilating work.

1940


Smoke is produced from smoke material to which a known amount of radioactive atoms has been added. These are best described in the form of molecules similar to the smoke material to be investigated. The radioactive isotope in such a smoke can be measured with an ionization chamber and an electrometer, but it is much better to count the single electrons. A counting chamber made of thin aluminum foil is described, which counts both negative and positive electrons.

After passing the smoke through a filter or subjecting it to other treatment the electrons are again counted in the same way. From these counts the effect of the treatment is judged. The method is easily carried out and is quick and accurate, but its usefulness is limited by the fact that radioactive isotopes of sufficient length of life cannot be produced and isolated for all elements and the cost is comparatively high. A practical experiment is described. (JIIJT)


Although cloth filters have been used for industrial dust collection for several years, very little fundamental work on their performance has been done. This preliminary paper covers the basic requirements of a good filter and describes the factors involved in filtration and their application to the industrial dust problem. Experimental data giving basic filter resistance coefficients for several kinds of dust of known particle size are included. The data suggest the following points: (1) The resistance coefficient increases many fold when the particle size varies from coarse to fine. (2) The resistance coefficient does not vary greatly among the several dusts studied when compared at equivalent sizes. (3) These data explain why certain materials like lampblack are hard to filter: This difficulty is due only to fine size of the particles.

Filtering velocity is shown to have little importance as a criterion of filter operation. In its place the use of a maximum allowable resistance of 3 in. water gage is recommended. This figure is a compromise between initial cost, maintenance, and power costs. It will provide safe operation for all but the very fine particle size dusts, such as lampblack.

Although the data presented are based upon laboratory studies, they illustrate that the prime factor is particle size. This is a fundamental piece of work, and more work along these lines will be of great value to dust-control engineers who are interested in filter performance and power economy. (JIIJT)


The basic laws of aerosol filtration are discussed with reports of experiments on filter materials of known porosity and structure with definite test vapors. The condensation aerosol of the dye sudan L is used as test vapor. With multiple layers of cellulose and rayon, the deposit of the precipitated vapor within the filter cross-section follows a simple absorption law. The percentage absorption power for numerous paper and silk filters as well as filter bricks and Jena glass frits was determined. The ideas of separation of dust particles by sedimentation, reflection, and spinning-out are transferred to aerosol filtration. The controlling significance of flowing motion for aerosol filtration was previously found for the system drying filter-airflow are likewise basic for the filtration of liquid suspensions. (JIIJT)

1941

2932. KUNDIG, E. Dry-Type Air Filters. Southern Power and Ind., vol. 50, 1941, pp. 70-71.

Gives a general description of air filters that depend upon settling the dust. A woven textile material and a felt are the most commonly used mediums, and their efficiency depends primarily upon the density. An all-wool felt has been found to be the best medium, as it is dense and yet does not offer the resistance of a woven material. Variations in air velocity do not affect the cleaning efficiency appreciably as long as the maximum velocity is limited to about 50 f. p.m. It is possible with a dry-type filter to obtain a cleaning efficiency of 95 percent and higher for dust particles less than 2 microns in size. Individual filters and typical installations are illustrated. (JIIJT)


Describes a portable smoke-recording instrument, which gives 24-hr. records. Air from a high-velocity jet impinges on paper driven by a clock and contained in an evacuated vessel. Constant flow through the jet is maintained by insuring a pressure drop of 0.33 times the upstream pressure, as in the common type of ejector flowmeters used for routine dust sampling.

A ring of darkened material is formed upon the paper chart as the paper rotates. The density of ring is measured by a photoelectric densitometer or it can be measured by a hand-operated instrument. Various degrees of dirt units are made up against standards and results interpreted accordingly. (JIIJT)

1943


A theoretical study of the filtration of dusts and smokes is presented, based on the assumption that a particle adheres to the surface it contacts irrespective of the contact angle. All the filters in use are based on the fact that the particles are subjected to a movement of their own in relation to the atmosphere in which they are contained. Three simple classes of filters are discussed as examples, namely, impact, centrifugal, and electric filters. Different filter systems have been investigated experimentally by separating the variables that intervene in their constitution and by calculating their stopping power on well-defined types of dusts. A brief account is given of the work actually going on at a research station, which comprises studies on the means of dispersion, on the means of control, and on the filtration of dusts and smokes. (FA)


A filter is constructed by felting a network of fine tetrachloroplatinate (I) crystals on a wire gauze.
AIR POLLUTION—A BIBLIOGRAPHY

Proper crystal size is obtained by precipitation in alcohol. If superior to other substances as it is resistant to shock, is nonhygroscopic, and retains very fine particles. To change the collected dust into an aqueous suspension for particle-size analysis, I can be solved in benzene and then removed by washing with water or by heating above 300°. (JIIHT) 1945

2936. [Tetrachloronaphthalene Dust-Sampling Filters.] Mem. services chim. état, vol. 31, 1945, pp. 74–82.

It is claimed that none of the soluble filters hitherto used in the sampling of dusts and smokes is suitable for the purpose. Preparation of a soluble tetrachloronaphthalene paper is described. The agent is dissolved in ether and added to alcohol previously saturated with the same agent. The ether is evaporated under reduced pressure, and the alcohol containing crystallised tetrachloronaphthalene is poured on a wire gauze on which the precipitate is allowed to dry. Dusts collected on these filter disks in a sampling apparatus can be recovered by dissolving the tetrachloronaphthalene in benzene or toluene followed either by decanting the liquid after the dust particles have settled or by evaporating the solvent on a water bath and then the tetrachloronaphthalene at about 300° C. The results obtained from both methods are in good agreement. (APB)


1945


Illustrates a portable dust extractor made in units from 36 to 48 inches high weighing 150 to 250 lb. The air current is maintained by 3-phase, CO-cycle, a. c. motors, 1/2 to 1 1/2 hp. The filter surfaces are bottomless tubes of fire-proofed fabric, and the largest unit is said to present 90.8 sq. ft. of filtering surface. The tubes are shaken periodically by hand, and the dust collects in a pan at the bottom of the unit. The filtered air is discharged through a sound-deadening muffler. (FA)


The apparatus is designed for removing suspended matter from air or gas by means of electric precipitation. (FA)


An electrostatic filter has been designed for rooms, and it is claimed it will reduce the bacterial population of the air by 99.9 percent. It is described as a cylinder, 70 cm. long, to which a potential of 14–35 kv. is applied. An ultraviolet lamp for air sterilization is mentioned also. It gives 34 percent of its radiation at λ2,800A, and can sterilize 40–50 cubic meters of air in 15 minutes. Fans blow the air against the lamp. (APB) 1946


Claim 1: An air filter comprising a frame open at its front and back and having an internal channel about its perimeter, a grating disposed in the channel frame in shielding relation to the rear opening thereof, a pad in said frame bearing against said grating and having marginal portions engaged in the channel of the frame, a door for the open front of said frame formed of strands disposed vertically and hori-

zontally in crossed relation to each other, and having end portions bent to form prongs projecting from the door for penetrating the pad when the door is closed, hinge plates secured to said frame at one side thereof and having portions rolled to form sleeves receiving portions of a vertical strand at the adjoining side of the door above and below a horizontal strand and pivotally mounting the door for swinging movement to opened and closed positions, and means for releasably holding the door closed.


The design of tube- or bag-type and screen-type collectors is discussed. (FA)


Air-filtering apparatus comprising walls of fibrous sheet material adapted to be positioned around a central member and defining a spiral unfiltered air passage extending more than a complete circle and also defining a spiral filtered air passage extending more than a complete circle, the filtered air passage terminating in a filtered air chamber adapted to substantially completely surround the central member, the unfiltered air passage terminating in a closure, a pair of flexible spacer members spacing the edges of the walls of fibrous sheet material from each other in the filtered air passage and adapted to space the edges from central member, a pair of flexible spacer members spacing the edges of the walls of fibrous sheet material from each other in the unfiltered air passage, and wires strengthening means for securing the walls of fibrous sheet material in position adjacent the outer end of the filtered air passage and adjacent the inner end of the unfiltered air passage. (FA)


Particulars of the design and construction of the “Pneu Mech” automatic textile-sleeve dust collector are given. In these dust collectors the textile filter tubes are suspended from a common tube plate over each compartment of the assembly. The lower end of each tube is closed and has attached to it a weight, which maintains the correct tension. Dust-laden air enters the bottom of the tube compartment and passes round the sides of the tubes through which it is drawn, and filtered. The filter tubes are cleaned by the usual method of periodically reversing the air flow through the tubes in successive chambers throughout the plant, and simultaneously agitating these tubes to loosen the dust clinging to the surface. (FA)


The unit consists of a number of cells with spaced sinuous plates covered with a thin film of oil, which are fitted by pins in a frame through which the air passes. The whole frame rests on sprocket wheels via the pins of the bottom cell, and at stated intervals the sprocket wheels are turned lowering the bottom cell into an oil spray tank where the cell is subjected for a short time to a high-pressure oil spray. The cleaned cell on the next turn of the sprocket wheel is lifted to the front of the bank and is replaced by hand on the top of the bank. Oil and sludge are circulated through a strainer. (FA)


Claim 1: A method of separating solids from gas containing the same, which includes creating an enclosed gas stream, deflecting at least a portion of said stream against the free surface of a liquid body, and thereafter passing said stream through and in contact
with a flowing layer of liquid in a path divergent to the direction of flow of said layer. (FA)

A filter comprising fibrous filtering material confind to form a hollow body and wherein the gas or air to be filtered first flows from the exterior through one part of the body to the interior space thereof and then through another part of the body into an exterior manifold or chamber having one or more outlets for the filtered air or gas. The filter can be applied to remove dust from the inlet air of internal-combustion engines. (FA)

In a filter unit for removing particulate matter from gases, a confined body comprising resilient nodules of mineral-wool fibers maintained in interlaced relationship by a hardened binder, the nodules being arranged generally in the form of layers and defining voids therebetween, and the nodules of successive layers varying in size from large nodules in a layer adjacent the entry face of the unit, to smaller nodules in a layer adjacent the air exit of the unit. (FA)

Claim 1: A filter for extracting dust, fibers, and other solid material from air wherein the dust- and fluid-laden air is drawn by fan suction into an inlet duct extending above a number of spaced filter compartments open to the inlet duct and having filtering material or perforated screens upon two opposite sides, with which cooperating wipers revolving within the compartments from which the filtered air passes to atmosphere through outlet ducts on opposite sides of the series of filter compartments, the material that adheres to the filter or screen surfaces being delivered into a dead space beneath the filtering material or screens. (FA)

This relates to devices by which dust-laden air is cleaned by filtering, for example, before being admitted to the intake system of an internal combustion engine and the like and comprising a casing having an inlet for dust-laden air, an outlet for filtered air, and a plurality of concentric cylindrical filters within the casing arranged so that the air flowing from the inlet to the outlet passes through them in parallel. (FA)

Claim 1: A replaceable filter cell for air filters, comprising a plurality of narrow strips of single face corrugated paper arranged in a stack, with the liners of one strip engaging the corrugations of the next, but not attached thereto, and a supporting frame for maintaining said strips in a unit, comprising a pair of end frame members, one at each end of the stack, and a plurality of transverse frame members secured to said frame members and the said corrugated strips to hold them in a unitary assembly and means for impregnating said filter cell and providing its external surface with a tacky material, comprising a sprayed and absorbed supply of adhesive compound, said transverse frame members being located in slots in the corrugated strips and being in frictional engagement with the said corrugated strips at the walls of said slots, the said transverse frame members extending from the face of the filter cell from said slots for the purpose of engaging additional filter cells and spacing the present filter cell from additional filter cells to provide a dead air space between this cell and adjacent cells. (FA)

Claim 1: In an air cleaner, a casing having a closed top and a liquid sump at the bottom, a filter holding partition in said casing and spaced from said casing to define a downwardly leading air path therebetween, a closed top on said partition shaped to define a chamber beneath the closed top of said casing and outside said partition equivalent in capacity to said chamber, said chamber receiving and retaining liquid from said sump in the event said chamber is inverted while in use. (FA)

Active carbon air filters in air-conditioning systems permit the recirculation of a greater fraction of the conditioned air, thus economizing in power or fuel for heating or cooling, as well as removing objectionable odors. Chemical plants can use active C to prevent the evolution of obnoxious fumes, and food-processing plants in industrial areas can satisfactorily purify the air by as much as 99 percent from acquiring objectionable odors. Other uses are cited. The active carbon can be used in canisters or in panels or frames of conventional air-filter size, containing one or more rows of evenly spaced, perforated, C-filled tubes housed in a metal frame. Although canisters purify all of the air, the panels are designed to purify a definite percentage, fixed by the number of tube rows and their spacing. (FA)

A gas filter adapted to remove from a gas suspended particles of ultramicroscopic dimensions and of less than 1 micron in diameter, comprising a filter casing having inlet and outlet openings, and a filter element of rock wool arranged in the casing for the flow of the gas therethrough, the filter element having a depth in the direction of gas flow of at least 0.25 inch and the rock wool having a density between 3 grams per cubic inch and 16 grams per cubic inch. (FA)

Gives theory of electronic air filtration and a description of the modern plate-type electronic air filter. (AB)

The various types of air filters are reviewed briefly, and their application to special ventilation problems is discussed. The efficiencies of modern filters are thought to be insufficient, and not until filtration has been put on a properly specified and tested basis with an accurately controlled test procedure will filter manufacturers be able to present a filter at a reasonable price thoroughly serviceable, easy and inexpensive to maintain and one that will fulfill the desired requirement for all industrial purposes. (FA)

The operation of aerosol is improved by impregnation of the filter fiber with a polystyrene dispersion. The efficiency of filtration is determined by passing through air carrying a known concentration of oil mist, and measuring the residual mist by light scattering. When treated with 1.2 percent, basis filter weight, of aqueous polystyrene dispersion (I. G. Farbenind./Poliostyl EF-Milch), the light scattering of filtered gases drops
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from 6–8 for the untreated filter to 0.005 for the treated filter. This latter value corresponds to 0-0.20 mg. oil per cu. m. No noticeable change in performance is observed after a 1/2 year storage. The operation is attributed to the insulating properties of the poly-styrene. (APB)

1947


Three main sections are included: (1) A review of the functions of an air-filter installation, with particular reference to the ventilating plant; (2) a summary of some of the relevant literature, chiefly of American origin; and (3) a survey of research on ventilating-plant filters. In the first part, the varying needs of different types of buildings and the various types of dust sampling are discussed. In the second, the work of Rowley and Jordan is reviewed. In the research reported in the third part, several types of filters—metal, wool, fabric, paper, glass silk, and cotton wool—are compared in efficiency under working conditions. Natural time and accelerated tests were included. Some empirical relations between efficiency, resistance, and velocity were established. Fabric and wool filters were found to have similar properties, and the conclusions of Page are supported. (FA)


The subject is discussed with particular reference to ventilation. (APB)


Claim 1: An air-filter cell comprising: An open face frame having peripheral side and end walls with face flanges extending from the walls inwardly across the margins of each face of the frame being extended reversely along one face of the frame being extended along the entire length of the cell to provide U-shaped sealing and securing troughs at each end along the inner face of the cell; sealing flanges extending along the inner face of each side wall between troughs; a flexible deformable medium extending in corrugated fashion from one sealing trough to the other with its straight end edges sealed in the troughs and its corrugated side edges sealed by the sealing trough; and a flexible corrugated wire screen extending in corrugated fashion along each face of the frame between its end walls, the corrugations of the screen being of relatively shallow amplitude in relation to the amplitude of the filter medium corrugations and the valleys of the inner face of the screen being positioned to receive the crests of the filter medium and engage them substantially throughout their length so as to hold the crests in spaced relationship and support the corrugations of the filter medium against displacement. (FA)


A mill in a town where soft coal is burned suffered damage to 5 percent of its yarn in compressed-air drying. Simple mechanical filters were tried and proved inadequate. The problem was successfully solved by installing an electrostatic filter cleaning the air going to the blowers. Tests indicate an efficiency of 90 percent. (APB)


Claim 1: An air or gas cleaner in which an endless perforated band is disposed up and down in zigzag fashion around a plurality of top and a plurality of bottom rolls so as to provide a plurality of vertical stretches between the top and bottom rolls and a horizontal stretch that passes through an oil bath, the band being moved continuously and the air or gas stream being directed through the oil-wetted vertical stretches of the band in succession. (FA)


Claim 1: Air filters for extracting dust fibers and other solid matter from air comprising filter screens disposed within a casing and an adjustable to one another to produce a substantially V-formation together with washers or brushes for each arranged in like formation and traversed back and forth over the filters by a cranked scroll or worm gear in a predetermined screw device while the air being filtered is drawn through the FA filters. (FA)


Gives a broad review of the use of tubular, envelope, or pod filters in conjunction with air-conditioning plants. Describes the Cheatham and Musgrave systems of air conditioning. (FA)


Claim 1: A filtering element for removing particulate matter from gases, the element comprising a plurality of superposed layers, each comprising a resilient mineral wool felt, with the layers thereof arranged predominantly in planes parallel to the contiguous faces of the layers and maintained in felled relationship by a set binder, and means acting transversely to the superposed layers under compression. (FA)


From a study of the effect of change of sheet density at constant sheet weight it was found that with sheets of constant weight, filtering efficiency for smoke is dependent upon sheet density and there is a maximum density at which maximum filtering efficiency is obtained. This relation holds whether the density is changed by means of wet pressing, beating, dry disintegration, or use of a dispersing medium other than H₂O. The correlation between sheet density and filtering efficiency at constant sheet weight is not the same for all sheet weights. The same type of correlation is obtained for several types of fibers. With sheets of constant caliper and varying density secured by varying the sheet weight, filtering efficiency is a function of sheet density; there is an optimum sheet density at which maximum filtering efficiency is obtained. When the sheet density is held constant and the sheet weight is varied, there is a correlation between sheet weight and filtering efficiency. Thus, there is an optimum sheet weight and sheet density for the maximum filtering efficiency for each pulp. Asbestos and diatomaceous earth, when added to the sheet in low concentrations, increase the filtering efficiency. Fiber length has little effect, but fiber diameter is an important factor in determining filtering efficiency, increasing with decrease in fiber diameter. The filtration appears to be due primarily to mechanical effects. No type of fiber tested showed any unusual affinity for the test aerosol, and examination of the fibers under the electron microscope suggested that the particles collected on a fiber were uniformly distributed over its surface. (FA)

A study of the smoke-filtering efficiencies of different fiber sheets is reported. A penetrometer, fully described in the text, was used for measuring both efficiency and removal of aerosol and resistance of air flow through the test specimens. Filtration was found to be due mainly to mechanical effects, and particles collected were found to be distributed on the fiber surfaces. Fiber length had little influence on filtering efficiency but this increased appreciably with decrease in fiber diameter. At constant fiber-sheet weight, filtering efficiency was dependent on sheet density, and this relationship appeared to be independent of the processing used to vary fiber density. For the greatest filtering efficiency, an optimum sheet density as well as an optimum sheet weight were found to exist for each type of fiber. Certain filters, such as asbestos and diatomaceous earth, produced an increase in filtering efficiency when present in the sheet in low concentrations. (FA)


Claim 1: An air cleaner, comprising a hood having cylindrical walls and an enclosing top wall; a dust chamber connected to the hood having walls substantially parallel to the cylindrical walls of the hood and spaced therefrom forming an annular air chamber; an annular flange on the cup engaging the cylindrical walls of the hood and overlapping another portion of the air chamber; short cylindrical walls and joining the inner edge of the flange with the deflecting walls, thereby forming a relatively narrow sheltered annular air zone between the short cylindrical walls and adjacent walls, there being a dust passage from the hood into the dust cup, and means for directing air into the air chamber and means for directing air from the air chamber. (FA)


Gives short account of the purpose of and results achieved with Saco-Lowell air filters, with data from actual trial runs. (FA)


Claim 1: In an air cleaner, a casing having spaced inlet and outlet openings and shaped to define a liquid sump, a removable filter element in the casing in the path of air traveling from the inlet to the outlet, means to hold the filter element in position within the casing, and means projecting from the filter element to limit the movement of the element in case the element becomes free, the last means also being connectable to the first means with the filter element in inverted position, the filter element being arranged to function with equal efficiency in either position. (FA)


Claim 5: In an air cleaner, a casing having a liquid sump in the bottom thereof and an inlet opening above said sump, a filter holding shell in said casing above the sump and spaced from the casing wall to provide an inlet passage leading toward said sump, a filter mass in said shell, said shell having an opening in the bottom to provide unrestricted communication between the filter mass and the entire sump therebeneath, said shell having a series of tongues struck inwardly from the side wall of the shell and extending inwardly and upwardly into the filter mass, said tongues leaving openings above the outer terminations of the tongues in the side wall of said shell above said sump to bypass air traveling reversely through the cleaner owing to back pressure and guide such air in a direction in conflict with reversely traveling air that reached said sump, and said casing having an outlet for air passing through said filter mass in the forward direction. (FA)


Stresses the advantages of using a water soluble liquid such as glycerin on air filters. As in some installations filters may be placed close to hot furnace pipes, it is of interest to know the flash and fire points of glycerin solutions. These are given in tabular form and they show that there is no unusual fire hazard since oils of similar flash point are used for the same purpose. (FA)


This illustrated bulletin describes the principles involved in ascertaining by air sampling and analyses whether or not a potentially hazardous atmospheric condition exists in a working environment. It contains tables showing the maximum allowable concentrations of atmospheric contaminants and explosive concentrations of gases, vapors, and dusts. Methods and apparatus of air sampling are illustrated as well as paper and flame test methods for an analysis. Practical methods and equipment employed in industrial air analyses are tabulated. Other methods discussed include dust determinations and identification. Determination of bacteria in air, flow measurements, calibration of sampling instruments, and aids for calculations in industrial air analyses. A bibliography of 139 references is appended together with list of commercial sources of air sampling and analytical apparatus. (APB)


A methane-filled proportional counter tube and circuit is described together with a means of attaching a paper filter. This filter is used to collect atmospheric dust, and the counter is used to measure activity of the dust. (APB)


Arrangement consisting of one or several filtering chambers separated by thin partitions suitable for mechanical, absorbative, and chemical filtration. The material of the partitions is a mixture of felt fiber, active carbon, and chemical reagents. (APB)


The theory, application, and recent developments of filter-type dust collectors are discussed. Filter- or dust-collector cloth does not itself collect dust but is a framework on which a filter "cake" is permitted to build; the filter cake collects the dust. Magnified cross sections are given of "five harness warp sateen" before and after napping to form "canton flannel" cloth, and also of felt cloth in various stages of use; other suitable materials such as asbestos, rayon, and nylon are included. The question of cleaning is discussed, and important points to be considered in evaluating shaking methods are enumerated. The disadvantages of using reverse air flow for cleaning are stressed. Methods of finding the proper ratio of air quantity to cloth area for a given operation and of determining the design of a bag-type collector are discussed. Notes are given on
AIR POLLUTION—A BIBLIOGRAPHY


This filter, which treats 10,680 cu. ft. of gas per sq. ft. of filtering surface per hour, is described and its aerodynamic principle is illustrated. It is claimed that the active surface is no more than 2 percent of that of a sleeve filter of equal filtering capacity. Characteristic features are that the orifices for gas passage are much larger than the dimensions of the dust to be retained and the orifices are inclined obliquely to the direction of gas flow so that undulating flow is produced in the proximity of the plate. (FA)


Claim 1: Apparatus for removing dust or other particles from air or gas wherein the air or gas first impinges against vanes or baffles arranged in spaced relation and inclined to the direction of flow of the air or gas, whereby heavier particles carried thereby are deflected by the vanes and fall by gravity on one side thereof, the air passing between the vanes or baffles to the other side thereof and then through a body of filtering material. (FA)


Presents the principles and operation of the bag filter. A modern baghouse will recover virtually all of the solids carried in the smoke stream and discharge into the atmosphere a solids-free waste gas.


In “equipressure” boilers in which the combustion chamber is under pressure (100 atm. or more), elimination of unburnt solid constituents is essential before the gas enters the turbine or engine. The diatomite filter is a simple solution of this problem. The gas is passed through a wall of suitable-size gravel about 8 cm. thick, which is held in position by a series of inclined shutters. If the gas is passed through at 0.5 m./sec., 90 percent of the dust is held by the gravel. Pressure drop is about 12 mm. water gage. The contaminated gravel is then dropped onto a 2 mm. oscillating screen and returned by a elevator to the filter. The dust is returned to the silo or returned to the furnace if rich enough in carbon for burning. Semi-industrial plant is described, adaptation on an industrial scale discussed, and diagrams are given of proposed arrangement. (APB)


The requirements of an adequate air-filter testing method are enumerated and what a test code should include to meet these requirements is summarized. In the belief that the first approach to developing an adequate test code lies in eliminating those variables in air-filter testing other than test dusts, a test dust, dust feeder, and dust sampler that allow the test dust to be evenly distributed within ±15 to 20 percent have been developed and described. Simultaneous dust sampling is used. It is recommended that complete performance curves or families of curves be furnished designers as a basis for proper filter selection. (FA)


Claim 1: An air filter comprising an orifice through which an air stream is arranged to flow and means arranged to cause at least the major part of the air

“problem” dusts, such as asbestos, high-temperature dusts, and dusts in extremely small concentrations. (FA)

1948


Claim 1: An air-cleaning device, having an inlet opening for the uncleaned air, a filter element for arresting dirt particles carried by the air, and an outlet opening connected to the suction conduit for the cleaned air, characterized in that between the filter element and suction conduit there is a chamber having oppositely directed nonreturn valves on inlet and outlet parts respectively, those on the inlet parts allowing cleaned air to enter the chamber under suction from the suction conduit but preventing the return of air in the event of a rise of pressure in the conduit, and those on the outlet parts allowing the escape of air in the event of rise of pressure but being closed by suction in the receiving conduit.


This relates to improvements in filters used for removing dust and foreign particles from the air drawn into an internal-combustion engine. (FA)


Claim 1: A filter for fluids, particularly air and other gases, comprising a sheet of self-supporting ferromagnetic material having a series of zigzag folds therein to provide parallel ridges facing alternately in opposite directions, wherein at spaced points in the length of the folds being in alignment to contact one with another and hold the folds properly spaced apart for the flow of fluid between them, and means for exerting a confining force on the folds, in a direction to keep such spread portions in contact.


A filter for air and gases is made by first crimping or corrugating a sheet or strip of mesh material then folding the corrugated sheet into zigzag form on parallel fold lines, making a substantial angle with the corrugations pressing the folds together until the corrugations in adjacent folds touch, and framing the compacted folded material in a surround frame, which leaves the peaks of the folds exposed for admission and exit on the gaseous stream. (FA)


Claim 1: Rotary air-filtering apparatus comprising a hollow cylinder having a filtering cylindrical wall, means for rotating the cylinder, means for drawing air to be filtered inwardly through the cylindrical wall, and filter-cleaning means contacting the outer surface of the wall to remove accumulated filtered material therefrom, wherein a brush is provided upon the cylinder to project outwardly therefrom and to engage the filter cleaning means periodically for the removal therefrom of filtered material accumulated thereon. (FA)


Describes a dust filter consisting of a slit through which the dust-laden air passes and two glass plates set parallel to the direction of flow. The relation between the fraction of dust removed and the linear velocity of the air in the slit is determined for slits of various widths and for plates at varying distances apart. The results are qualitatively discussed in terms of vortex formation. (FA)
stream, before entering the orifice, to flow across the orifice in a direction substantially parallel to the plane of the orifice the air then flowing back to the orifice by way of a curved path, there being no partition or baffle between the air flowing across the orifice and the orifice. (APB)


Claim 1: A self-supporting gas-filter material comprising a mixture of felted animal fibers and electrified particles of a substance having a specific volume resistivity greater than 10^10 ohms per cm. cube and a surface resistivity greater than 10^16 ohms per cm. square. (A10,675) (FA)


The usual impurities found in the atmosphere and the size of particles are classified. The various air-filter systems are outlined. Methods for testing filters are given and their behaviors are compared; the results of tests are given in terms of particle size retained. Various air-filter-system arrangements are discussed. (APB)


Claim 1: A liquid-bath air cleaner with a casing through which the air flows and with a liquid sump in the bottom of the casing and a filter in the path of the air from the inlet to the outlet of the casing, including a filter holding shell bonded to the inside wall of the casing in one region and spaced therefrom otherwise to define a passage for the entering air leading towards the sump. (FA)


Claim 1: An air cleaner, with a casing and a filter in the path of air traveling from the inlet to the casing, and with a liquid sump below the filter medium, characterized by the fact that the casing is shaped in the region of the sump to provide an outer annular open trough beneath the passages for the air and a central well of greater depth than the trough, there being interposed an inwardly extending antisplash flange at the top of the central well to prevent liquid from the central well passing into the trough by virtue of sudden movements of the vehicle carrying the cleaner. (FA)


This relates to improvements, particularly to an air cleaner of relatively small overall size for use with motorcycles, light jeeps, and similar vehicles powered by a comparatively small internal-combustion engine. (FA)


This relates to improvements particularly to air cleaners of the liquid bath type for use with internal-combustion engines. (FA)


Claim 1: Air to be cleaned flows through a casing having an inlet and containing a filter element including as part of the filter element a filter mass holding shell above a sump in the casing, the shell having an opening in a wall thereof below the air inlet to the casing and above the sump level to bypass air traveling reversely through the cleaner. (FA)


This relates to cleaners, especially of the liquid bath type, for use in connection with the air intake of internal-combustion engines, air compressors, and other apparatus. (FA)


3002. ——. Filter Element or Unit for Air Cleaners and Method of Making the Same. British Patent 615,446, 1948. (FA)

Claim 1: A method of making an air-filter element or unit from vegetable fibers, including the step of curling the vegetable fibers around a mandrel, treating the curled fibers to set the curl, and bending the curled fibers together at random into a uniform mass.


A dust filter in which one or more bags extract the dust from the dust-laden air or gas while it is passed through the pores of the bags, these being periodically agitated and at the same time subjected to a counter-flow of air or gas to remove the dust from them. This invention provides a simplified and efficient means for effecting the periodic agitation of the bags and reversal of air or gas flow. It comprises a dual can having a section with teeth to shake the bags and a section to operate the control valves for the air or gas, the valves being loaded so as normally to occupy the position in which dust-laden air will flow to the bags and scavenging air will not, and the cam section that operates the valves being arranged to hold them in the opposite position, that is, the position in which scavenging air will flow to the bags to be cleaned and dust-laden air will not, against the action of the loading means while the teeth forming the first-mentioned section of the dual can shake the bags. (APB)


A dust filter in which one or more filter bags extract the dust from dust-laden air or gas while it is passed through the pores of the bags, these being periodically agitated and at the same time subjected to a counter-flow of air or gas to remove the dust from them. The invention provides operating mechanism and values of simple, light construction having few moving parts, readily replaceable and adaptable to varying conditions of speed and allowing a large number of bags to be included in the cycle of operation. It consists of an endless chain provided with members in the form of cans adapted both to control the valves and to bring about the requisite agitation of the bags as the chain is driven. (FA)


Claim 1: A dust receiver comprising two compartments of which one is defined by walls of a material impermeable to air and has an inlet opening at its lower end to receive the dust-laden stream of air and the other compartment is formed by walls that comprise material permeable to air wherein a wall separating the two compartments forms an impermeable partition that extends upwardly from the lower part of the receiver and an opening is formed in the upwardly extending partition at the upper end thereof so that the dust-laden stream from the first compartment moves through the opening into a substantially undiminished velocity in a substantially horizontal direction so that the dust in the dust-laden stream of air is caused to settle downward in the other compartment while the air passes through the permeable material. (FA)


An air filter known as the Precipitron filter, utilizing the principle of the electrostatic precipitator and giving a superior performance, has been developed and fits within the range of reasonable capital cost by adopting standardization of parts and is being pro-
duced in sizes suitable for use in commercial and industrial air-conditioning systems. The filter is assembled in three parts—the orifice, the dust-collecting cell, and the power pack. The filter is described. (APB)

Claim 1: An air filter comprising an orifice through which an air stream is arranged to flow and means arranged to cause it to pass at least the major part of the air stream, before entering the orifice, to flow across the orifice in a direction substantially parallel to the plane of the orifice, the air then flowing back to the orifice by way of a curved path, there being no partition or baffles between the air flowing across the orifice and the orifice.


The Musgrave aerodynamic dust collector is described. The filter surface consists of a specially slotted steel sheet bent into a cone. Slots are placed so that the dust is discharged in contact with the filter surface and therefore erosion is not high. There is little tendency for the filter to become clogged. (FA)

The annual report of the National Smoke Abatement Society for 1947 makes the comment that, from a long-difference viewpoint, the attention that had to be given during the year of the whole nation to the problem of fuel may prove to be of substantial value to smoke abatement. Understanding is gradually spreading that if our fuels were used more efficiently the present production of coal would be ample for all our needs. The society comments on the material increase in the number of complaints of "nuisance" caused by grit emission, although it says that it is difficult to obtain quantitative evidence. The report welcomes the measures that are being taken to improve the quality of coal, and to increase the efficiency and economy of grit-arresting appliances, but the society would like to see the latter used more generally in medium and small installations.
The hope is expressed that the society's "National Survey of the Sources of Pollution" may provide more information on the extent of grit and ash emissions throughout the country. (FA)

Claim 1: Apparatus for filtering dust or solid particles from air or gases and incorporating a main chamberlike casing partitioned into a plurality of vertical compartments or sections wherein the filter bags are arranged as usual, characterized by the provision in each compartment or section of the main casing of a horizontal platelike member, herein referred to as the shaker plate, and each furnished with apertures corresponding in number with the number of filter bags provided in the compartments wherein it is arranged, one of which bags passes through each aperture in the shaker plate and is secured to a spigotlike part surrounding the aperture, the shaker plate in the respective compartments being adapted to perform guided vertical rising and falling motions therein under the action thereon of cam disks. (FA)

The object of the invention is to retain the advantages of the known construction of filter and, at the same time, to obviate the necessity, for cleaning purposes, of dipping the inner frame and plates first to clean them and then to recast them with oil. (FA)

Claim 1: Apparatus of the class described comprising a rectangularly shaped canister having an inlet port adjacent to one end and an opening adjacent to the other end, a plurality of baffles arranged in staggered relation to provide a circulation channel for receiving an air-purifying material and with some of the baffles being arranged to form a wall opposite the opening, a tubular mouthpiece mounted in the opening to form a close sliding fit, the inner end of which mouthpiece encloses the wall to be protected, and the outer end of the mouthpiece is forced inwardly into engagement with the wall, means for maintaining the air-purifying material in spaced relation to the mouthpiece and the mouthpiece being long enough to extend through the opening with its outer end arranged in proximity to the outer surface of the canister and being movable outwardly from the wall to provide an outlet passage therethrough for the purified air from the canister. (FA)

An improved type of apparatus is described. This device uses an unimpregnated pleated cellulose filter, which can easily be changed and cleaned. Gravimetric or chemical procedures may be used for analysis. (FA)


A filter for air or other gases in which a series of brushes is arranged to be used so that their bristles just touch or are intermingled by an amount too slight to impose restraint on the brushes, and means are provided near the meeting place of adjacent brushes to divert the gas towards the center of the brushes. (FA)

Arrangement consisting of one or several filtering chambers separated by thin partitions suitable for mechanical, absorptive, and chemical filtration. The material of the partitions is a mixture of felt fiber, active carbon, and chemical reagents. (FA)

Dust filters containing only a fibrous filtering medium were found to be unsatisfactory. When fibers were impregnated with polyvinyl about almost complete cleanup was obtained. A theoretical discussion of the electrical effect of the resin which is believed to be responsible for the high filter efficiency, is presented. (FA)

Various types of cloth filter fabrics are discussed; the fabric to be used for each application must be decided with respect to the specific conditions applying there. Cloth filter is best cleaned by a shaking or beating mechanism; this should use the power economically to remove the dust cake rapidly and efficiently without getting the cloth too clean, as the filter cake in the actual filter. Reverse air-flow cleaning systems have serious disadvantages. In desigining filters, the air-to-cloth ratio should be as high as possible. Bag filters are described and illustrated;
the length of a bag should never be greater than 30 times the diameter; lower limits should be used when collecting material of low density. The application of cloth filters to the collection of fine materials, extremely small dust concentrations, and high temperature is discussed. (APB)

1949

3020. AIR MAXX, LTD. Method and Apparatus for In-
hiating and Humidifying of Air and Gases. British

The method of treating a stream of air or gas for
filtration or humidifying that comprises causing such
stream to flow through an assembly of corrugated
sheets of wire mesh or other foraminous material ar-
anged endwise to the stream. The corrugations of ad-
jaent sheets cross to prevent nesting and to provide
alternate zones of expansion and restriction in the path
of the fluid passing between them and also allow fluid
to pass through them. (FA)

3021. ASTREY, H. Filters for Gaseous Media. British

Refers to filters for gaseous mediums and is particu-
larly applicable for collecting the carbonaceous content
such as soot, which is thereby filtered from flue gases.
(APB)

2,453,501, 1949. (FA)

3023. BRAND, A. N. Air-Filtering Apparatus. British

Claim 1: Air-filtering apparatus for dust extraction
of the kind in which the filtering means comprise fabric
fibres, sleeves, or bags, wherein the tubes, sleeves, or
bags are attached at their open upper ends of suitable
connection members forming the cleaned air outlets
from a filter chamber and are held distended by rein-
forcements except at their lower ends, which are partly
closed but have openings that close during the normal
operation of the filter but are free to open when the
normal air flow is stopped to permit escape of dust
from the interior surface of the tubes, sleeves, or bags.
(FA)

3024. ——. Air Filtering Apparatus. British Patent
618,685, 1949.

Claim 1: Air-filtering apparatus in which air to be
cleaned is passed through textile fabric filter tubes or
like enclosures which are open at one end, characterized
in that each tube or the like is provided at the other
end with a removable closure to permit the entry at that
end of a scouring current of air, which passes along the
filtering surfaces of the tube or the like. (FA)

3025. BOSS, W. J. Air-Purifying Device. United States

Claim 1: An air-purifying screen comprising a pair
of inwardly facing vertical side frame members, a hori-
zontal bottom pan secured to the lower ends of the side
frame members, a horizontal top pan secured to the top
ends of the side frame members, a vertical front brace
member secured centrally between the front edges of the
top and bottom pan, a vertical rear brace member
secured centrally between the rear edges of the top and
bottom pan, the vertical brace members being V-shaped
in cross-section and facing inwardly, a plurality of
sheets of wire mesh positioned between the vertical
brace members and received within the perpendicu-
larly to the side frame members, and a filling of loosely
packed deodorant material between adjacent sheets of
wire. (FA)

3026. DAHLMAN, Y. Air Filter. United States Patent
2,486,520, 1949.

Describes an electrical precipitating unit. (APB)

3027. DE VILHENA COMPANY. Air-Washing Means. Brit-

3028. ENGINEERING. Centrifugal-Type Flue-Gas Dust

Gives details of the most recent design of Sirocco
cellular dust collector, which achieves a high efficiency
over a considerable range of boiler loads when dealing
with flue dust from stoker-fired or pulverized-fuel
boilers. (FA)

3029. FENL, O. E. Air Washer. United States Patent
2,763,455, 1949.

3030. HARR, J. L. Air-Cleaning Apparatus. United States

Claim 2: In an air-cleaning device the combination
with an air circulating fan having a casing forming
an inlet suction side and a pressure outlet side, the
former extending vertically and open at its top, of a
cylindrical screen axially supported above the top
of the inlet, of a hollow drum depending from the screen
and surrounding the inlet, vanes mounted in the drum,
an air nozzle connected to the pressure side of the fan
casing extending vertically within and adjacent to
one side of the screen and a receiver on the exterior
of the screen for the material dislodged by the blast
from the nozzle.

3031. HOWDEN, J. AND COMPANY, LTD., AND LEE, L. Dust

Claim 1: A multicell dust collector having a structure
including a hopper for the reception of and collection
of separated dust, a plurality of dust separator cells
within the structure and mounted for the discharge
of separated dust directly into the hopper, a dusty-gas
inlet conduit for supplying dusty gas to the structure
and arranged to distribute dusty gas to the separator
cells, a clean-gas outlet conduit connected into the
structure and arranged to receive clean gas from each
of the separator cells, an independent dust separator
exterior to the structure, at least one conduit between
the independent separator and a point of the structure
adjacent to the position of the inlet conduit and ar-
ranged to receive gas discharged from the separator
cells into the hopper from a position above the collected
dust in the hopper, a gas-circulating fan, and conduits
connecting the fan with the independent separator
and with the clean-gas outlet conduit, the fan and
the conduits associated therewith being arranged to
draw gas from the hopper to the independent separator
and to draw clean gas from the independent separator
and discharge it into the clean-gas outlet conduit. (FA)

3032. INDUSTRIAL HYGIENE NEWSLETTER. Los Angeles
Industrial Hygienists Active in Many Fields. Vol.
9, 1949, p. 13.

Mentions among other matters a joint meeting of the
local industrial units and the county air-pollution con-
tral district. The incentive behind this meeting was
to insure that if the air-pollution district recommends
a filter on the exhaust outlet, it does not result in back-
ing up the toxic material into the plant. Similarly,
if industrial hygiene recommends exhaust ventilation,
it should be so arranged that people living in the
vicinity would not be subjected to a health hazard.

3033. LOPEZ, R., AND ALLEN, B. Air Cleaner. United

3034. McDIIL, R. D. Detection of Impurities. United

Claim 1: Measuring apparatus comprising a casing,
a horizontal extending conduit therein for sampling
air to be conditioned in an enclosure remote from the
light. Tight closures at the ends of the conduit, a square
of light within the conduit adjacent to one of the closures,
a light-sensitive element within the conduit and an air
sample therein and adjacent to the other closures, a
draining inlet conduit communicating with the first-
mentioned conduit, and upwardly extending exhaust
conduit communicating with the first-mentioned conduit
adjacent to its other end and having a plurality of offsets, the inlet and outlet conduits sensitive elements, a heat device positioned below the lower end of the inlet conduit, electrical amplifying apparatus within the casing and responsive to the light-sensitive element and arranged to operate a relay, a source of current controlled by the relay, and electrically operated air-conditioning apparatus for the enclosure operated by the current and controlled by the relay. (APB)

Mists composed of sulfuric acid droplets, 2 to 14 microns in diameter, were filtered from air at substantially atmospheric temperature and pressure by passing this air through beds of solids fluidized in a 2-inch tube. Beds of nonporous materials like silica and glass beads showed an impractically short life, but porous materials like commercial microspheres, silica gel, and aluminia picked up over 5 percent, by weight, of acid before sticking destroyed fluidization. Removal efficiency, defined as the percentage (by weight) removal combination of a fraction of the air, was substantially constant during the life of the beds and independent of the entering concentration over the range of from 20 to 120 pounds of acid (100 percent basis) per 1,000 cubic feet. For a given fluidized bed, removal efficiency increased with increasing bed weight per unit area and with increasing superficial gas velocity. With porous solids of 170-40 mesh and a bed weight per unit area of 52 pounds per square foot, a maximum removal efficiency of over 90 percent was obtained with a superficial velocity of 3 feet per second, corresponding to a pressure drop of about 6 inches of water across the bed. Removal of air from ammonium nitrate smokes by fluidized solid beds now under study shows results somewhat analogous to acid mist removal. (APB)

Claim 1: A filter for filtering dust-laden air or other gases, the filter of the kind comprising a frame, with two previous faces that is filled with a red or granular filtering material being characterized in that it comprises at least one outside-operated poker permitting thorough agitation of the whole of the granular filtering material to prevent the latter from being clogged. (FA)

The object is to provide filtering apparatus of high efficiency for dust-laden air, gases, or vapors, including smoke, which is of the wet type but uses little water and no compressed air and offers no resistance to the passage of the gas or vapor, but is able to create a suction. (FA)

Claim 1: A filter for the filtration of air or other gaseous fluids comprising at least one filtering unit formed by the combination of a frame containing a filtering material and provided with two parallel previous faces and a lid which is in contact with the frame adjacent to one of the previous faces and comprises a lateral opening for discharging the filtered gaseous fluid, characterized in that the previous faces of the frame are horizontally disposed, the lid being removable and secured adjacent to the upper of the horizontal pervious faces. (FA)

Claim 1: An air cleaner including a housing, an annular wall defining a separating chamber within the housing, a separable closure for the housing and cham-
ber having means for directing an air stream into the chamber in a circular path, and an air conductor communicating with the chamber for conducting air therefrom, the chamber having a plurality of openings in its lower portion for permitting foreign matter from the air stream to pass into the lower portion of the housing. (FA)

Relates to filters for air or other gases of the type comprising a series of metal plates formed with deep V-shaped undulations and disposed vertically side by side at spaced intervals to present sinusuous channels for the passage horizontally through the filter of the gas to be cleaned, the plates being coated with a viscous liquid to retain the solid matter in suspension in the gas. (FA)

Claim 1: A filter for air or other gases wherein the strips are provided at one end of each V-shaped undulation thereon with a stop, the stops extending across the troughs of the undulations to engage the edge of a plate assembled thereagainst and prevent transverse movement of the plate relatively to the strip in the direction of the stop. (FA)

The author explains the operation of an air washer and using a psychrometric chart by Carrier, shows how the condition of water or of air at any point in the process can be determined. Both parallel-flow and counterflow types are discussed. (FA)

A method of quantitatively measuring resistance gradients through unit types of filters having packs of reasonable thickness and of such nature as to be readily severed has been devised. Five different types of filters chosen at random were subjected to five combinations of test dusts and lint. The nine tests reported were chosen as representative of the results to be expected with this type of analysis and are not indicative of a comprehensive test program. Results are reported as a series of resistance gradient curves through the filtering mediums at different stages of the tests ranging from the initial unloaded filters to the fully loaded filters with a total resistance of approximately 1 in. of water. (APB)

A liquid-bath air cleaner. (FA)


Claim 1: An air-filtering unit comprising a pair of spaced substantially parallel circular plates each having a pair of circular flanges one at its periphery and the other adjacent to its center extending towards the other plate; a tubular support for the plates, of smaller diameter than the flanges thereof, extending from the center of one plate through the center of the other and rigidly fastened to the latter, the protruding end of the support being adapted to connect to an air intake line, and the support having an aperture opening into
the space between the plates for passage of air; a pair of cylindrical grids having the surfaces thereof covered with flocks, mounted between the plates, respectively engaging a peripheral and center flanges thereof to be positioned thereby; a pair of rings having flanges mounted against the inner surfaces of the circular path, the rings having means for positioning the rings centrally of the plates; a zigzag grid covered with flock, mounted between the plates and engaging the flanges to be positioned thereby, the grid extending in a star-shaped path between the cylindrical grids so that air entering the apertures of the support will first pass through the grids consecutively and be filtered thereby; and means demountably fastening the one plate to the support so that the grids may be demounted when the plate is removed. (FA)


Claim 1: An air-filtering unit comprising a pair of spaced substantially parallel plates having correspondingly located circular edges; a pair of spaced substantially parallel rollers each extending from one plate to the other at points adjacent to the edges; a filter material embodying a substantially circular piece of screening, a portion of which is supported for filtering between the plates adjacent to the circular edges, the remaining portions of the screen being rolled around the rollers whereby turning the filter will bring succeeding portions of the screen into use; a plurality of guide rollers extending between the plates, mounted in staggered relation with each other along the circular edges, the screen extending in-and-out between the guide rollers to follow substantially a zigzag, generally circular path; an imperforate housing mounted between the plates, having opposite edges engaging the screen adjacent to each of the rollers, the housing extending from one roller to the other so that the screen and housing thereby enclose a space between the plates; an aperture in one of the plates, providing an air passage from the enclosed space; and a second sheetlike filter screen connected at opposite edges with the housing adjacent to the rollers, the second screen being extended between the plates closely adjacent to the circular edges, and enclosing the zigzag portions of the first-mentioned screen whereby air being sucked out of the enclosed space between the plates through the aperture is first damping unit in passing into the space through the screens. (FA)


A new dust collector has been developed for dealing with flue dust from either stoker- or p. f.-fired boilers, in which it is claimed simplicity and robustness have been combined with high operating efficiencies and low-pressure losses. This collector can be fitted directly in the flue system. (FA)


Claim 1: In an air-cleaning apparatus, an air intake chamber, an air cleaner unit within the air intake chamber with its upper end bridging the cross-sectional area of the latter, the unit comprising end-walls having downward and inward inclined side margins, a series of vertically spaced apart upwardly inclined partitioning members at each side of the unit respectively extending from an intermediate interior zone of the latter to the respective sides thereof of the intermediate interior zone providing a central descending air-flow path within the unit, spaces between the partitioning members providing a plurality of ascending air flow path to respective open sides of the unit, catch basin means extending between the end walls intermediate inner margins of the lower-most partitioning members whereby to close the lower end of the descending air flow path and reflect the air flow into the ascending ducts, and interstitial separator material mounted on the upper faces of the partitioning members contiguous to the ducts formed by the latter. (FA)


This relates to the class of air cleaners that utilize liquid, such as water, as a medium for entrapping the dust in the air to be cleaned and collecting it in the form of a sludge for disposal. (FA)

1950


Claim 1: An air filter having a flexible traveling band mounted for movement between a filtering region and a cleaning region with the band in the filtering region constrained to move along a sinusuous course between closure means engaging the marginal edges of the band, wherein the band is mounted so as to enter the filtering region along a path adjacent to that by which it leaves the region, and the band in the filtering region is arranged to cooperatively with the closure member to surround and enclose a space from which air filtered by passage through the band is withdrawn transversely of the direction in which the air passes through the band. (FA)


The document is in abstract form; it is reproduced below in entirety.

Available information on sampling atmospheric impurities by filter-papers has indicated that numerous intimately related variables affect efficiency of collection. These include such factors as the type of paper, sampling velocity, relative humidity, particle size and physical properties of the contaminant, and possibly atmospheric concentrations.

To elucidate this problem, studies using a filter-paper sampling train followed by a flame photometer were made to evaluate end losses. Sodium chloride aerosols at an average relative humidity of 52 percent were selected to permit simple analysis with the flame photometer. Particle-size measurements obtained from electron micrographs of samples collected with a thermal precipitator showed a mass median diameter of 0.3 μ and a geometric standard deviation of 1.74. Under these conditions, experimental data showed that the penetration losses to the flame photometer remained constant irrespective of the amount collected on the filter paper up to a 2.5-mg. sample. The flame photometer was found to have a limit of sensitivity equivalent to 30 g NaCl/m², and a standard error determined from known solutions of 2.2 percent.

The studies thus far have been limited to the effects of sampling velocity and concentration on the efficiency of Whatman No. 41 filter paper. Aerosol penetration of progressive numbers of elements of a filter-paper train were measured by the flame photometer at a sampling velocity of 39.2 cm/sec. from a concentration of 43 mg/m³. The concentration passing the first paper decreased from 2.94 to 0.03 mg/m³ passing the sixth paper, which represented the limit of sensitivity of the flame photometer and only 1 percent of the amount passing the first element. A plot of the cumulative total efficiency of the train showed a value of 99.92 percent for 6 papers. The curve rises rapidly from 93.4 and above 4 elements approaches the 100 percent value asymptotically. To permit analysis of samples collected by filter-paper trains only, the concentrations collected on each of the elements for these studies were expressed as the cumulative percentage.
increase above the value of the first paper. A plot similarly shows the increase in efficiency with increasing number of elements of the filter-paper train, approaching a limiting value of 7.1 percent asymptotically. The efficiency of a single paper obtained from the value of 98.3 percent, is in excellent agreement with that obtained from the flame-photometer results.

Detailed analysis of samples collected with the multiple filter-paper train only was made at an average concentration of 29.8 mg/m³. Sampling velocities at 8 points from 7.2 to 149.8 cm/sec., was explored using trains of 5 to 10 filter papers. Plotting the concentrations collected on each element, as above, a family of curves were obtained each of which approaches a limiting value asymptotically. These results led to the use of this limiting value to determine the efficiency of the initial element.

The number of elements required to sample the atmosphere completely was found to be directly related to the sampling velocity. Thus, at 140.8 cm/sec., the initial paper showed an efficiency of 99.6 percent and a minimum of 2 papers was required for significant results, whereas at 7.2 cm/sec., the initial paper showed an efficiency of 71.3 percent and a minimum of 8 papers was required. A range of sampling velocities from 7.2 to 142 cm/sec. were explored with more than 14 determinations made at 15 sampling velocities in order to obtain statistically significant results. Typical data of 9 samples at 38.1 cm/sec. showed a range of velocities maintained from 37.0 to 41.0 cm/sec, with efficiencies from 93.2 to 99.7 percent. The mean results show a rapid increase in efficiency with increasing sample rate from 7.2 cm/sec. up to 36 cm/sec. with efficiencies of 73.3 and 94.5 percent being found, respectively. With further increase in sampling velocities, the efficiency increased more slowly, gradually approaching 100 percent with the highest recorded value being 99.6 percent at 142.4 cm/sec. Concentration studies due to date on the effect of sampling velocity on efficiency at levels of 31.0 and 10.5 mg/m³ do not show that efficiency varies with concentration.


Claim 1: An air-filter medium comprising expanded sheets packed in filter panel form, each sheet consisting of a network of interconnected vanes coated on all surfaces with a viscous liquid.


The report describes a relatively inexpensive new paperlike filtering material that removes contaminants before the used air is discharged into the atmosphere. Other possible uses for this filter paper also are mentioned, such as purifying ventilating air in biological laboratories and in hospital operating rooms.


This paper discusses primarily the filtering devices used to clean air and gas discharged to the ambient air, emphasizing especially the widely used cloth, screen, tube, or bag collector. The characteristics, resistance, and life of filtration mediums are discussed, as well as the characteristics of aerosols to be filtered. Information is included on requirements, rating and testing, cost, and maintenance of various types of filters. (11 refs. cited.)


Claim 1: A filtering installation comprising means to isolate from the main flow one or more selected units at a time for cleaning and means for therupon diverting in the reverse direction through the filter material of the isolated portion, some parts of the cleaned air or other gas coming from other units, which continue in normal operation. (APB)


A group of vapor contaminants that are undesirable because of odor or noxious effect on plant and animal life is not affected by most of the particle-removal devices. Absorption and adsorption are the two principal physical means of separating undesired vapors from the carrier gas.

Absorption occurs when the vapor being absorbed moves completely into the absorbing substance or is attracted strongly to the surface of the adsorbing substance.

The theoretical and practical aspects of these methods of removing gaseous contaminants from the air are discussed and compared.

Always, however, control of air pollution must be developed by analysis of the pollutants and their source, followed by application of the best corrective techniques for each job.

1951


Describes a scrubbing tower for dusts, fumes, and gas employing high-velocity (up to 600 p. s. l.) hydraulic fogging nozzles. The principle on which this device operates is in no way connected with filtration in the usual sense in which this term is employed. Inconsistencies appear in the data tables, which tend to cast some doubt on the author's general conclusions. For example, (1) an efficiency of 87 percent on lead smelter fume is claimed, but the data cited indicate that the efficiency is actually greater than 97 percent; (2) the sum of the components of the inlet loading are significantly greater than the stated total inlet load, whereas the reverse is true for effluent loading.

Final evaluation of this unit must await a more detailed and convincing exposition as well as a more extensive program of controlled tests.


A portable electrostatic precipitator-type air sampler is described, in which the sample is aspirated through the precipitating tube in which a high-voltage electrode is located and in which the precipitated particles settle on a removable aluminum tube of rectangular cross section. The apparatus works from a standard alternating current source, with a 13,000-volt step-up transformer for the precipitator. (AIHOM)


A series of simple field experiments in testing bag-type dust-collector fabric for pressure drop and dust retention are described. The experiments were successful enough to make the principles involved widely applicable.

The tests described are said to be particularly useful when comparing dissimilar fabrics, such as wool with synthetics, napped with unmopped, or woven felted. In any such case of operating characteristics, particularly frequency and duration of shaking, may have to be radically changed. Indications of the necessary changes would be noted as a result of testing.


Performance characteristics of (1) asbestos-containing cellulose filter papers, (2) 1.3 and 3.0 gauge glass-fiber beds, and (3) analytical ash-free filters are
compared. Efficiency tests were made with atmospheric dust and 0.34 diameter droplets of dioctyl phthalate. After a short initial period for plugging, asbestos-containing papers (developed for the government during and after World War II) remove more than 99.90 percent of the above particulates at a flow rate of 25 c.f.m. per sq. ft. resistance of approximately 1 inch H₂O gage. When preceded by an electrostatic precipitator or prefilter, these papers have reasonably long life and are suitable for bomb shelters, removing toxic dusts and fumes of industrial origin, and precleaning bacteria and dust-free atmosphere very effectively.

A 1-inch thickness of the smaller-diameter glass-fiber medium (1.3g) was 99.4 percent efficient (by count) for atmospheric dust at a flow rate of 27 c.f.m./sq. ft. and resistance of 1.5 inch H₂O gage, whereas, for this same aerosol, Whatman No. 42 filter paper was 0.5 percent efficient at a flow rate of 30 c.f.m./sq. ft. and resistance of 5.0 inch H₂O gage. (IHOM)


Wilner describes an electrostatic precipitator designed especially for sampling very dilute aerosols. High voltages are generated in a coil set operating as a high-frequency transformer and rectified to supply two separate variable circuits. This technique has been reported by J. K. Brown, and others (Ind. Hyg. Quart., vol. 3, 1951, p. 294). Four electrostatic precipitating tubes compose the complete unit. The operating potential is about 7,000 volts, and the collection efficiency 100 percent for sampling rates up to 1,500 liters per hour. (AIHOM)

1952


To prevent air pollution by sulfur dioxide, hydrogen sulfide, and fatty acid odors, a high-pressure fog filter is used to remove contaminants from refinery fumes. (APB)


One of the many sources of air pollution is the escape of dust from cutting, crushing, grinding, pulverizing, screening, mixing, and packaging of many industrial products. When no attempt is made to suppress the dust arising from these and similar operations, it permeates not only the atmosphere near these operations but, because a large percentage of dust particles are in the low micron range of size, they will float for hours and spread over the neighborhood of the manufacturing plant.

Instances are cited in which the dust recovered by an effective filter unit is of value. The plant manager of one company found many demands for such dust until finally it became a primary product of the company.

Details of the operation of such a collection system are presented.


Describes the fine-gas-washing plant at a boiler plant installation providing steam for process steam and generating electricity. The fuel is coke breeze, which is fired on chain grate stokers, and gives rise to a considerable dust nuisance. The washing plant consists of 5 hopper-shaped washer filters arranged to work in parallel, the method of operation being indicated diagrammatically. (APB)


Deals with air pollution from refinery operations, discussing major sources of pollution and describing control measures especially by use of a fog filter. (APB)


Installations of fog-filter units and an asphalt oxidizer fume-disposal system are described in a report on scrubbing devices for air-pollution control. (APB)


Viscons impingement filters operate on the fundamental premise of dividing and subdividing the air flow into innumerable small streams using a multiplicity of baffles or elements. These minute streams of air are caused to change direction many times in their course of travel through the mediums. The dust particles, because of their inertia, cannot follow the changes in air flow and impinge upon the mediums' elements, and thus become trapped in the adhesive film.

There are three fundamental phases of performance of an air filter that are of primary consideration to the user: (1) Collectance efficiency; (2) dust-holding capacity or life; and (3) resistance to air flow. A well-designed filter will represent a compromise in which these three operating characteristics are balanced one against the other.


A method of manufacturing any one of up to at least 11 different standard forms or sizes of dust extraction plants of the type in which the dust-laden atmosphere is extracted through fabric bags from which arrested dust is removed by mechanical shaking. (FA)


Cloth-bag filters have been used for generations to separate solid particulate matter from aerosols. The general category of bag filters may, for purposes of this discussion, be construed to include cloth-tube and cloth-screen filtration apparatus which incorporate means for periodically removing accumulated material from the surfaces of the filter media. Cloth filtration finds wide industrial application in removing dusts and fumes from gases and is particularly applicable in instances where high cleaning efficiencies and nominal power consumption are required. Particles ranging from 0.01 micron to coarse screen sizes may be successfully filtered at collection efficiencies above 90 percent, by weight, of the material entering the collector, depending on the nature and properties of the particles and the proper selection of filter material and filter-cleaning method.

Different types of filters and their application to filtration of various kinds of air pollutants are discussed.


The characteristics of various types of filter beds utilized for air and gas cleaning are described. The discussion is devoted primarily to particulate aerosols. Many types of filters and mediums have been used for this purpose. Mediums may be fibrous or composed of various types of filtration media. A description of the effect of aerosol properties on performance as well as influence of filter bed characteristics is given.

Filter beds can be separated into two classifications: (1) Static beds and (2) fluidized beds. The characteristics of both types are underlying theory and principles governing their operation and performance are
included. The variable gradient bed and its possibilities are outlined also.

Consideration of the important factors such as efficiency, pressure loss, life, and power cost is presented with regard to all possible applications.


In recent years development work for the Atomic Energy Commission has led to production of practical air filter units of extraordinarily high efficiency. These filters are made of a special asbestos-bearing paper arranged to get large surface in a small volume.

Normally occurring atmospheric dust particles in the size range of 0.2 to more than 1.0 micron in size may number in billions of particles per cubic foot of air. Against such dust the new type filters show, by count, a collection efficiency of 99.98 percent or better. An effective method of measuring filter efficiency against such small particles makes use of the high speed jet impactor.

Paper filters are more costly than the more usual ventilating-type air filters and operate at a higher pressure drop. For most purposes a rougher dust removing device must be used ahead of the fine filter. This protects the clean-up filter against a high dust load, while the latter insures nearly complete removal of all particulate matter from the air stream.


The smoke control at a gray iron foundry has been solved by using silicates-impregnated glass bags. Particle emission varied between 0.8 and 1.6 grams per cu. ft. of stack emission (mainly mineral ashes, SiO2, and Fe oxides), of which 75 percent was <0.005 mesh and could be easily removed. The balance is removed in the glass bags, and silicate impregnation increases the life to about 2 years. The high-temperature service of this material reduces cooling requirements and eliminates coke and grease deposition. The effluent gas at 2150°F is air-quenched in a ceramic-lined outlet to 1100°F, and is further cooled in mild steel plates to 400°F, when it enters the bag; these operate at 3–4 inch water-gauge pressure. Once weekly, the cleaning fluid from the hoppers is emptied by screw conveyors. (APB)


Discusses mechanisms for filtration of particles from gas streams in viscous flow using dry fibrous filters. Both mechanical and electrical types are considered. The approach of particles near enough to make contact with the fibers is the basis of mechanical-type filters. Inertia effects in the case of large particles and diffusion arising from Brownian motion in the case of very small particles increase the chances of filtration. Maximum penetration is found for particles of intermediate size of about 0.1 to 0.3μ diameter. Performance of mechanical-type filters is enhanced by using very fine fibers such as asbestos. Electrical-type filters consist of fibers coated with a layer of charged resin particles. Electrical forces arising from the filter structure attract particles to the fibers. The radius of action of the fibers is thereby increased and a high efficiency filter material is produced. Methods of testing with a methylene blue stain test and a sodium flame test are discussed briefly. Characteristic data for actual filter materials, and their application to preparation of performance specifications are considered. Detailed specifications are included by way of illustration. (APB)


When subjected to an air stream, certain plastic resins, and waxes develop an electrostatic charge of sufficient magnitude to attract and retain particles of dust, smoke, soot, and other dispersed solids from the atmosphere. When prepared in suitable form such electrostatic materials serve as effective self-charging electrical precipitators.

Air filters made of porous masses of these materials will remove dust and carbonaceous smoke particles from the air when employed in heating and ventilating systems. Such filters are economical and easily cleaned. Atmospheric humidity within the normal ranges has very little effect on their efficiency.

The effectiveness of these filters has been established by extensive laboratory tests employing a new method of evaluation and has been demonstrated by numerous test installations in heating and ventilating systems. (15 refs. cited) (Authors' summary)

FLY-ASH RECOVERY

1930


The subject is discussed from the standpoint of the fineness of fly ash and just what part and how much of that part is necessary to recover to eliminate the fly ash nuisance.

A total recovery of 70 to 80 percent, provided this includes practically all of the plus 300-mesh material, will meet every requirement and permanently eliminate the possibility of a fly ash nuisance.

1936


Dust, as used in this paper, is classified as a dust particle greater than one one-thousandth of a centimeter in diameter, which is 10μ.

Two finer classifications of dust are given as clouds and smokes. Clouds are made of particles ranging from 0.0005 to 0.0005 cm. in diameter, say from 10 to 100 μ. Smokes would consist of finer particles, ranging from 0.1μ to 1.0μμ. Dust, as classified above, will settle in still air, with increasing velocity of the particles. Clouds will settle in constant velocity in still air, according to size, while smoke does not settle in still air.

The following five possible methods of dealing with this problem are discussed: (1) Using a large settling chamber, so that the dust will fall out by gravity; (2) by the use of an electric precipitator; (3) by washing with water sprays; (4) by centrifugal means; (5) fabric filters.

1938


Smoke and fly ash are considered separately from the standpoint of technical analysis.

Smoke subjected will always be had with any fuel-burning equipment in burning of any kind of fuel other than an inherently smokeless fuel. Only very expensive equipment, such as the Cottrell precipitator, can prevent smoke leaving the stack.

Fly ash is continually leaving the furnace. Much of it, particularly the larger sizes, may never reach the stack outlet. In connection with the spreader stoker, smoke and fly ash are thought of as leaving the furnace rather than the stack. Although the spreader stoker, the use of which is discussed, has
several inherent advantages over various other types of fuel-burning equipment, inherent freedom from smoke and fly-ash emission is not one of them. With properly operated equipment, one would meet city smoke ordinances as well as other types.


The analysis of fly ash discharged from the stack, with the gases, serves as a tangible means to tell how efficiently the coal has been burned, as a high percentage of combustible in the fly ash indicates improper firing conditions or incorrect control or regulation and, thus, represents a direct loss.

The size of dust particles that are commonly discharged under different firing conditions, the varying distances to which the varying sizes are carried, and the area over which the dust or fly ash is dispersed are discussed in detail.

The amount and size of fly ash or cinders discharged from stacks vary with the type of stoker used. The range of efficiency of dust-collecting equipment, required to relieve the nuisance, with the various types of stokers is given.


Discusses some of the profitable uses of fly ash that have been developed in England. The extended use of powdered fuel has produced this fly ash in such quantities that it has become a major problem of how either to dispose of the ash with no benefit or to utilize it in some useful and profitable way.


A general survey is made of the present use of pulverized coal in Great Britain, the future trends, the methods of fly-ash entrainment, and the slag-tap furnace.


Smoke is defined as the colored discharge of a combustion process, the intensity of the color depending solely on the concentration of particles of soot. The ash is the collective name for all other gas-borne solids, usually less finely divided than soot, and may or may not have carbon associated with the ash.

There is this essential difference between the earlier soot problem and the latter phase of fly ash—the elimination of soot was accompanied by increased efficiency and financial advantage. The prevention of fly ash will not offer any financial advantage, unless a use for the fly ash is discovered.

Some of the methods and equipment used for the elimination of fly ash are described.

1939


Experience is related with a water spray devised to combat fly ash coming from a chimney.

1940


Fly ash is defined as all solid particles emitted to the atmosphere resulting from the combustion of fuel.

The abatement engineer’s problem of fly-ash reduction includes consideration of methods of separating fly ash from the products of combustion before they reach the top of the stack and the amount of ash to be expected. Fly ash permitted to accumulate too much in one place, such as along the bottom of the breeching, may suddenly lift and create an immediate nuisance.

Keeping all passages clean is a great help. Figures showing various methods of separating fly ash from the products of combustion are presented and explained.


Coal products emitted from industrial and domestic fires constitute the major portion of polluting matter in the atmosphere.

The matter of nuisance formation as it occurs in the combustion chamber is discussed. A sample of fly ash emerging from the stack is comprised predominantly of ash, with an appreciable measure of unburned carbon. Smoke in its specific form usually constitutes less than 1 percent of the total by weight. Any study of fly-ash abatement should be concerned primarily with dust particles larger than 5 or 10 μ. Particles smaller than 10 μ are as small as particulate matter that normally circulates in the atmosphere.

The effectiveness of a dust collector installed for flue-dust extraction is probably best evaluated: (1) With respect to its efficacy in removing dust in the nuisance range, and (2) with respect to overall collection efficiency.

The operation of the three distinct types of collectors (simple inertial separators in which coarse dust is removed from the gas stream by a baffle system, with consequent rapid direction in change of gas flow; cyclonic separators in which both coarse and fine particles are precipitated under the action of centrifugal forces and electrostatic separators in which dust particles are ionized and caused to wander cross stream under the action of high electric potential) is explained.

1943


The collection and disposal of fly ash from spreader stokers, as well as the characteristics of fly ash, its composition, and factors affecting its production, are emphasized.

The four essential factors of combustion—mixture, air, temperature, and time—are applied to the underfeed stoker, then to the spreader stoker, to determine the extent that fly ash can be controlled.


Various methods for determining of fly-ash particle size are described. Such determination is needed because the nuisance factor of any dust discharged into an atmosphere is a function of the size particle composing that dust. Also, it is necessary to know the particle-size distribution of the dust to predetermine the possible reduction in stack discharge by installing dust-collecting equipment.

1944


American cities can be free of fly-ash nuisance by modern recovery methods. Smoke elimination is not enough, as a clean stack may be the source of destructive and wasteful fly ash and cinders.

The discussion is limited to the boiler plants, with various types of coal-burning equipment, such as pulverizers, underfeed, chain-grate, and spreader-type stokers.

The typical benefits resulting from the use of the fly-ash recovery equipment are utilization of cheaper coal; reduction of carbon loss, which frequently is substantial; reduction of stack maintenance through use
of stack stacks; reduction of induced draft for maintenance; prevention of damage to bearings and plant machinery; prevention of contamination of the products manufactured, which, in turn, is reflected in reduced production costs.

1946


A number of points are dealt with that will aid in minimizing smoke hazard in industrial districts: (1) Cleaning fly-ash accumulation at base of stack by stirring the ash so that it is discharged out of the stack. This easy method of getting rid of fly ash is one of the principal causes of heavy dustfall. The proper method is to wet the surface of the ash accumulation at the base of the stack before the cleanout door is opened. (2) Cleaning breeching and settling chambers in boiler at irregular and infrequent periods. When fly ash accumulates in a breeching or other space intended for gas passage, fine-gas velocities increase. As a result, ash is prevented from settling out of the stream of the flue gases. (3) Burning rubbish in base of stack or on grate of unused boiler, with doors open. This practice permits the discharge of large quantities of burned paper into the atmosphere. (4) Using cleanout door in breeching or at base of stack as a means of securing ventilation in a boiler room. An open cleanout door reduces the average rate of air in the furnace, thus causing it to smoke. (5) Blowing tubes with dampers wide open or at frequent intervals. When tubes are open, discharge of solids range up to one hundred times the normal discharge. Great care should, therefore, be exercised when tubes are being cleaned. (6) Operating a steam ash ejector, which is directly vented into boiler stack. A steam ash ejector directly vented into a boiler results in fine ash being discharged out of the stack. (7) Allowing continuous discharge of light smoke. In many plants, little or no attempt is made to reduce light smoke discharge from stacks; yet the total dirt discharged into the atmosphere may be much greater when a stack operates with a light continuous smoke than when the same stack emits heavy smoke for relatively short periods. (8) Failure to remove dirt accumulation on roof. Heavy winds sweep up dirt accumulation on roofs and spread it. (9) Delivery of untreated fuel containing fines. Fines of untreated coal are spread over neighborhood when dumped. Heavy winds sweep away considerable amounts of the fines if the coal is allowed to remain in an exposed pile for any length of time. (FA)


An open-cycle gas turbine burning pulverized coal is to be developed by the Locomotive Development Committee of Bituminous Coal Research. A specific problem is to remove excessive carbon particles of larger diameter, from the hot gas coming from the combustion zone before it enters the turbine. Excess air is to be used for cooling the gas to a safe level. A gas-cleaning device must be obtained that is capable of operating at a temperature of about 1,400 °F, and at a pressure ranging 40 to 100 lb./sq. in. The device must operate effectively with a low static pressure loss, must greatly reduce the dust content, and must remove all particles larger than 8 to 10 microns. The cyclone type of collector seems most suited to the required conditions, the Institute is to study the characteristics of small diameter cyclones, particularly the 2- and 3-inch diameter Aerotec models. Testing with loadings of 0.15 to 3.0 gr./cu. ft. of fly ash, temperatures up to 1,400 °F, and pressures up to 100 lb./sq. in. A second phase is the study of the abrading action of fly ash suspended in air at the pressures, temperatures, and loadings above and at velocities to be expected in a turbine on targets of various metals. The effect of particle size will receive special attention. (FA)

1947


Discusses the prevention of atmospheric pollution by smoke and fly ash from small boiler plants by training stokers, using proper equipment, and catching cinders for return to the furnaces. (FA)


The removal of fly ash from this pulverized-fuel-fired generating station was long a matter of great difficulty, whether the ash was handled dry or saturated with water. When dry, there was dust nuisance, which was due to the very small particle size of the material; when it was wetted with water it either would not flow at all or formed a slurry, which caused difficulties at the leading plant. Test-tube experiments showed that control of the solution containing the ash is possible by adding cresols and 2 to 3 percent of a resin soap. The data obtained in these experiments have been adopted as the basis of the process of fly-ash handling recently installed at Ultimo Power Station. The work proved successful, inasmuch as the ash can now be discharged from the station for rail or road transport, without dust or slurry nuisance. (API)

1949


Cupola operation involves burning coke under forced draft, producing a dust consisting mainly of fairly coarse coke particles, with very little smoke, except during the brief lighting-off period. This dust does not contribute greatly to air pollution; but in the Los Angeles area, in particular, a reduction in this dust may be required by law, and it is well to look for economical means for its suppression. Five methods are described briefly, and in the appendix eight methods with smoked data and usually with reports from foundries that are using the methods. A questionnaire used in obtaining these reports is presented. Reports have also been obtained from various city administrations regarding the success of their abatement programs. Many of the reports indicate that cupola dust suppression is a relatively new science and research and cooperation with industry are recommended. Finally, it is suggested that the cupola dust may have commercial value, as fly ash is now found to have value in making cement, asphalt roads, concrete blocks, and molding sand. (IHD)

1950


The feeling that testing for fly-ash emission for the small boiler plant requires too much time and equipment is not necessarily true. The requirements of a good, authentic fly-ash emission test are listed, and performance of the test is described in some detail.


A $5-million powerhouse-modernization program for Akron, Ohio, plants that will increase electrical-distribution facilities and at the same time reduce discharge
of fly ash from company stacks by 90 percent has been announced by the Goodyear Tire & Rubber Co.

Powerhouses will be changed over to control this material that now escapes with the flue gases. The initial step in the program will be to install fly-ash collectors on high-pressure boilers and to replace low-pressure boilers at plants with high pressure equipment.

The fly ash, instead of passing from the powerhouse stacks, will be deposited in hoppers, from where it will be forced by compressed air to silolike storage bins. The material will then be dampened with water and shipped to product concerns for use in building blocks and road-surfacing materials.


Fly ash, collected by modern dust arresting filters, usually contains 75 percent or more dust finer than 325-mesh. It may amount to 70 percent or more of the weight of incombustibles in the coal. These fine sizes and large quantities preclude practical separation from water without installation of expensive equipment or large settling ponds. Fine dust may be separated from air with relatively low loss and with low expense. For this reason, it is general practice to convey fly ash pneumatically in a system separate from the hydraulic system serving the primary furnace hoppers.

Pneumatic fly-ash-handling systems may be designed for a wide range of conveying rates. The manual, semiautomatic, and automatic sequence control methods are discussed briefly.


The detailed requirements of a fly-ash collector for the small boiler plant are discussed. The requirements for the abatement of the fly-ash nuisance are today considerably different from those of only a few years ago.

The major small-boiler fly-ash-collector requirements may be summarized as high efficiency to abate the nuisance and meet present day stricter requirements; low draft loss suitable for operation, either under natural draft or mechanical draft, without large expenditure for fans, motors, and power; adequate storage of collected fly ash to permit practical high-efficiency operation in service, as well as practical disposal; durable self-cleaning construction to insure continuous high-efficiency performance; low first cost, including cost of labor and auxiliary equipment; and low operating cost, including costs of power, maintenance on collector, as well as auxiliary equipment, and absence of costly restrictions on boiler output or boiler shutdown due to collector failure.

The fly-ash collectors may be divided into the following general types: Raffle, primary concentrator, with secondary collector of high-efficiency cyclones, high-efficiency cyclones, and electric precipitator.

The requirements and types of collectors are discussed in some detail.


The problem of disposal of fly ash (combustion product of pulverized coal) is presented, together with several specific examples showing how the companies concerned are coping with the problem. In most cases, the precipitated or trapped ash is placed in water for ease of handling and drained or pumped to a settling basin where the “fly-ash fill cements to a firm mass.” Basins are preferably designed to last at least 5 years, 30 where possible. In some areas there is a ready market for fly ash (can be mixed with cement), and the problem becomes one of storage rather than disposal. However, fly ash is still used in such limited quantities that it must be considered an industrial waste rather than a byproduct. (PHEA)


Although installation of fly-ash collectors in any particular plant should always be studied as an individual exception, there is an overall pattern that enables one to classify a specific fly-ash problem and to predict roughly the cost of collecting a designated percentage of the total dust.

Efficiency requirements, type of fly ash, and types of collectors are discussed. In general, a good job of fly-ash collection can be done more cheaply on a stoker-fired boiler than on a pulverized-fuel-fired boiler. The cost differential increases with finer pulverization. In either case, however, the higher the efficiency required, the higher will be the cost, with the cost rising very rapidly as efficiencies approach 100 percent.


The basic factors affecting the emission of fly ash and cinders from the burning of bituminous coal under boilers are coal size, type of firing equipment, gas velocities, turbulence of combustion, dust collection, and dust reclamation. Dust collectors in the boiler breechings reduce the amount of dust discharged from industrial chimney, but the quantity and combustible content of the dust leaving the furnace are governed by the combustion process.

Dust from industrial boilers is discussed, with emphasis on the processes in the furnace. The conditions for meeting legal restrictions on dust emission are analyzed for a hypothetical boiler, which is equipped with a spreader stoker and a dust collector. (17 refs., cited)


Methods are described for fluxing radioactive incinerator residues with molten sodium hydroxide. This procedure eliminates the handling of dry ash and wet collection methods and permits ash to be transferred to a final disposal point in a compact convenient form. At 1,000°F, NaOH will dissolve 30 to 50 percent of its weight of ash, so that 2,500 pounds of combustible waste containing 1 percent of ash may be handled by a 100-pound charge. Ordinary carbon steel is a suitable construction material.

An automatic sampler for airborne particulates is described, which may be used to collect successive hourly samples of 25 to 40 cu. ft. over a long period, with a minimum of servicing. Particulate material is retained on Whatman No. 52 filter paper. (HOM)

1952


A review of methods of measuring the concentration of fly ash in flue gas, particle-size determination, and the reduction of dust-emission by the use of dust-extractor plant. (APB)


Describes and illustrates how Anheuser-Busch cut fly ash emitted in a 24-hour day, at full load, to less than formerly expelled in 2 hours, by installation of electrostatic-precipitation equipment. Research is being conducted to determine possible uses for the fly ash collected. (APB)
AIR POLLUTION—A BIBLIOGRAPHY


Smoke from a boiler passes through a sampling tube having an inspection port fitted to it, with a light source on one side and a photocell on the other. The frequency of the alternating-current component of photoelectric current is the number of relatively large dust particles that pass through the port per second. An air-liner and detector enable this quantity to be measured and recorded, while the much smaller smoke particles do not affect the output. (APB)


A flue-gas washer devised by the Leningrad Technological Institute has been tried successfully in the laboratory and at a power station. It is said to remove 96 percent of ash and about 90 percent of sulfurous anhydride. Operation is based on conclusions from the laws governing diffusion processes. It consists of a reservoir with a grid. The gas is led under the grid, and water goes on the grid. The gas is distributed through the holes in the grid, passes through a layer of water, and forms with it a moving foam. No foaming agents are required. The height and quality of the layer of foam depend on the type of grid, the gas velocity, and the height of the silt at the water outlet. A production model has been constructed. (APB)


Problems in coal-ash disposal and utilization raised by the increased use of pulverized coal are studied. Two main possibilities of utilization of substantial quantities of dust emanate, namely, as a constituent of concrete and as a bituminous material for road surfacing, flooring, and roofing. While the B. E. A.'s apathetic attitude to the use of flue dust for producing building bricks is criticized, reference is made to the successful reclamation of marshland by the B. E. A. at some power stations by forming a subsoil of the material. (APB)

FOG DISPERSAL

1943


The foggy air is drawn through a light metal cylinder (earthed) in which a wire is suspended axially on insulating supports, being charged to a high negative potential. The fog particles are thus precipitated on the cylinder walls, and the increase in weight of the cylinder gives the water content. Suitable dimensions of the apparatus are given. (FA)

1945


Short account of the part played by the Gas, Light & Coke Co. in the preliminary experiments for operation "FIDO." (FA)

1959


Describes the centenary exhibition which contained an exhibit of the fog-dispersal equipment known as FIDO. (FA)

1945


An account is given of the development of the Hades and Rapex burners in connection with fog-dispersal investigations. (FA)

1946


Answering questions in the House of Commons, Mr. Ivor Thomas, Parliamentary Secretary of the Ministry of Civil Aviation, said that in view of the very high running costs of "FIDO" and the low revenue from it, the installation would not be proceeded with. The minimum estimate received from Heathrow had been 70,000 gallons of petrol per hour, which, with petrol at 1s. 9d. per gallon, worked out at £3,250 per hour. Assuming five aircraft to be handled in the hour, it worked out to about £437 for every aircraft handled. The ultimate solution of the landing of aircraft was in the development of radar, which was proceeding most satisfactorily. (FA)

1946


A series of experiments, carried out by the Royal Aircraft Establishment during the early part of 1939, had shown that an improvement in visibility during fog could be achieved by burning a mixture of 82 percent alcohol and 20 percent petrol, the alcohol having been added to reduce smoke; but, due to the high consumption, approximately 4 gallons per yard per hour, the scheme was abandoned at the outbreak of war. However, the need in 1942 was so urgent that arrangements were made to erect two full-scale experimental installations of this type, capable of burning 20 gallons of petrol per yard per hour. At the same time, indoor experiments were carried out at the Earl's Court ice-skating rink, where artificial fog could be produced. In the course of the full-scale tests it was noticed, however, that some burners produced less smoke than others, and it was found that this was due to the petrol having been vaporized in the burners by the heat of combustion. Efforts were made, therefore, to vaporize the petrol in various forms of burners. Different arrangements were tried before adoption of the "Haigas" type, in which the supply lines were arranged alongside the burner pipe. The "Haigas" burner was superseded by the "Haigill" burner, in which the preheating pipe, approximately 20 yards long, was supported above two burner pipes, the preheater pipe forming the apex of an equilateral triangle. A transportable installation, called the "Halfox," was developed from the "Haigill."
CONTROL OF AIR POLLUTION 341

In which enough petrol gas was developed in a 6-coil vaporizer, 7 feet 6 inches long, to supply a burner pipe 76 feet long, and this type of burner was used successfully by the Second Tactical Air Force in France. An adaptation of the "Halifax" principle was arranged so that it could be installed in trenches covered by steel grids, thus making it possible to install a complete system without offering any interference to the movement of aircraft on the airfield. (FA)

The work of the Petroleum Warfare Department in relation to fog dispersal is recorded. (FA)

1947


After defining the nature, cause, and physical characteristics of a fog, a method for thermal dissolution of ground fog is described and the results of practical defogging tests according to this method are presented. (FA)

Claim 1: The method of clearing fog from open spaces which consists in producing a curtainlike jet of air from an orifice or orifices suitably arranged along one or more sides of the area to be cleared, and discharging air from other orifices (the air being treated before or after leaving the other orifices) so that it shall drift across the area under the entraining influence of the curtain, whereby the treated air is caused to clear fog over the area during the passage of the treated air over it. (FA)

The mechanism of the use of sound waves for dust precipitation is explained, and the fields in which the method appears promising are mentioned. Preliminary tests with natural fog indicate that power consumption may be important but is only one-tenth the amount consumed as fuel by the "FIDO" method of fog dispersion. (FA)

This relates to the dispersal of fog by an installation involving heating the atmosphere by flames. (FA)

The disorganization of work in shunting yards during periods of fog and the delays caused thereby would be alleviated by the use of a fog-dispersal system. It is stated that two British railway companies have interested themselves in the matter. The article describes the FIDO system used at airports and the American "Go Fog" equipment by which fog dispersal is caused by the projection of calcium chloride into air. Other dispersal methods under trial are a "water-screen" method used from a trailer a mechanism which brings about by vibration the agglutination of fog particles, which become too heavy to stay in suspension. (FA)

Claim 1: A method of precipitating relatively stationary ground or sea fog, comprising subjecting a foggy atmosphere to controlled sonic vibrations of changing and random frequencies substantially continuously over a period of time sufficient to cause the suspended fog particles to collide and coalesce into larger aggregates which fall to the ground. (FA)

1948

Earlier methods had the disadvantage of the fog not being lasting or being electrically charged. A continuous generating process is described, which closely resembles natural conditions. The bottom of an experimental fog chamber 60 cm. square and 155 cm. high is covered by a cooling element in water. The source of vapor is placed in the top and consists of a brass tray with bottom of asbestos, through which diffusion of vapor takes place. A heating element keeps the water in the tray at a temperature of 300° C. To simulate the linear vertical temperature gradient, such as occurs in natural foggy air, the brass walls of the tray are extended down to the bottom. The air necessary to supply fresh condensation nuclei, the amount of which can be controlled, passes slowly upward through the chamber and escapes at the top, along the sides of the hot-water tray. The degree of supersaturation required to produce fog and the vertical vapor pressure and temperature gradient are calculated. In a large region between the cold and hot surface the vapor pressure is shown to be higher than the saturation pressure corresponding to the local temperature, causing condensation on nuclei. The size of the droplets is the same as in natural fog. The density of fog can be controlled by varying the temperature at the hot surface. (FA)

Ultrasonics are vibrations about 20,000 c. per sec. The development of more powerful means of producing ultrasonic waves led to an investigation of their properties, and many possible applications were proposed, although relatively few have reached the stage of practical use. The possibilities include direction and depth sounding, geological surveys, examination of metals for flaws, dispersion of metals and colloids, emulsification, and coagulation of aerosols. The methods of production of ultrasonics and a description of their effects and practical applications are given. (FA)

The requirements laid down by bomber command and possible solutions are stated. The method actually used (direct heating of the foggy air by flame from coke or liquid fuel) is described in detail, with photographs and diagrams, and operational results are stated. (FA)

The efforts being made and experimentation with foundry industries in southern California for reducing the volume of smoke released are discussed. This interest is in response to the general concern over the smog, which reduces visibility and, on severe days, causes irritation of the eyes of persons in the downtown area. (USPHS)

Gives a history of the fight against smoke in Pittsburgh, a preciser of the latest smoke ordinance, methods used towards smoke abatement (use of diesel engines, mechanical stokers, and low-volatile coal), and future trends in smoke elimination. (APB)
A BIBLIOGRAPHY

1950


The results are given of a study made at the Meteorological Laboratory of the Pennsylvania State College, using artificial fogs.

The results of many statistical studies generally point to greater persistence of fogs in areas of pronounced air pollution. This stabilization of fogs in more polluted air may be explained by the effect of electrostatic charges. The production of aerosols by combustion processes is connected with strong ionization. Therefore, the fog droplets will acquire a greater electrical charge when the concentration of electrified nuclei is high. The electrical charge on fog droplets has been shown to have a stabilizing effect on the fog by reducing coalescence. In addition, the idea advanced that "fog particles becoming coated with oily hydrocarbons" evaporate less easily may apply to these experiments in a modified sense. The hydrocarbons not only hinder evaporation of the droplets during the later stages of fog development, but probably also retard their initial growth.

In addition to a further study of the problem of incomplete combustion, many related problems, such as the effects of various types of fuels, the temperature of the fog, turbulence of air motion, etc., still await experimental investigation.


The theory of fog dispersal by spraying a mass of fog or cloud-bank with a hail of electrified particles is evolved. Whereas fog scavenging by means of neutral particles would require 20 tons per km² of scavenged area, charged particles would reduce the requirement to 550 kg. per km². Factors that have been ignored in this theoretical consideration are indicated. (PIFIA)

RECOVERY OF GASES AND FUMES

1915


Describes in detail the methods used in determining the contamination of the air and the damage to trees, crops, and livestock by the smoke and fume from the Selby smelter, in California, and gives the conclusions of the commission on the methods used by the smelter company to prevent injury. Is of especial interest to metallurgical companies, municipal or State boards of health, and persons investigating damage by smelter smoke.

1932


A discussion is presented to the effect that sulfur of coal produces sulfur dioxide and that this in turn produces sulfur trioxide, which with water forms sulfuric acid. It is sulfuric acid that causes the injurious effects on people. Ways and means of eliminating sulfur dioxide from the flue gas and coal before burning were devised and are discussed in detail. (USPHS)

1939


Gives a general summary of the conclusions reached in the investigation in a form useful to those desiring to know the possibilities in this method of soot removal; a list of the composition of compounds that have been proposed, patented, or sold; and a detailed report of the tests made and the results obtained.


Different types of flue-gas scrubbers are described, which, if properly installed, should recover at least 90 percent of the solids in flue gases.


The successful results with an installation designed to burn colliery fines and slurry, where the flue dust is automatically removed from the boiler flues and intercepted before reaching the atmosphere, are described.

1939


Methods used by white-lead manufacturers to utilize the carbon dioxide present in flue gases.

1941


The latest authoritative treatment of the subject of smelter-smoke damage had been described in Bureau of Mines Bull. B 98—Report of the Selby Smelter Commission. The art of protecting vegetation from the effects of smelter smoke has greatly advanced since that publication and has undoubtedly reached its highest point in the operation of the Trail smelter, B. C., where smelter fumes were reaching property in the State of Washington. This report is a complete description of the smoke-control tests and policies developed at the Trail smelter and incorporated in the regime for the operation of the smelter which was determined by the International Tribunal established for that purpose. Published in collaboration with the Meteorological Division of the Air Services Branch, Department of Transport, Canada.


An account of the development of sulfur dioxide measurement and control at the Trail, B. C., smelter. As much as 700 tons of sulfur dioxide may be emitted daily, but now the manufacture of sulfuric acid and elemental sulfur can reduce the gas emissions to limits that do not affect vegetation. Promising progress has been made in forecasting periods of low atmospheric turbulence during which gas fumigations of vegetation can occur. It is now possible to alter operations frequently so that no gas escapes from the stacks during the periods of low turbulence.

The presentation of this paper with its accompanying graphs is exceptionally well done and will interest anyone concerned with problems of air pollution.

1945


1945


The various types of preventative devices are described and compared. Mechanical collectors are effec-
of the coarser materials, but are not particularly effective on material of 325-mesh or finer; the also set back pressures of 15,000 to 20,000 lbs. per sq. ft. or higher. Scrubbers are probably more efficient than the mechanical type in removing the finer material, but corrosion must be guarded against, and the steam evolution may be objectionable. Precipitators are 90 percent or more efficient in removing both coarse and fine materials. The pressure drop through the equipment is usually less than 1/4-inch water column, and power requirements are usually about 0.5 to 0.75 kw-hr. per 100,000 cu. ft. of gas treated. (APB)

**1946**


At the last meeting of the London County Council and the Housing and Public Health Committee recommended that the Minister of Health be asked to set up an independent body to inquire into the extent of the discharge into the air of sulfur and its compounds from installations procuring and generating electricity consuming large quantities of coal. The committee further suggested that such an independent body should determine and advise on the best measures which could be taken to extract sulfur and its compounds from the flue gases emitted by generating stations and other installations consuming large quantities of coal. (FA)


An example has been studied of some important secondary consequences for dwellers in the neighborhood of certain industrial undertakings. It is a practical proposition to extract fluorine from fumes before allowing them to pass into the atmosphere. This is already the practice of some firms. In the example studied the substitution of closed kilns in the burning of Ironstone would make the amount of fluorine present in the ore and coal immaterial from the public health point of view, but methods for such fluorine control are at present too rarely applied in Great Britain, because fluorine hazards are not sufficiently appreciated. (APB)

**1947**


The report covers the combustion of spoilbanks, tuleene control, and benzol recovery, smoke abatement, and discharge of gases and fumes from registered and unregistered works during the years 1939–45 and the steps taken to prevent excessive discharge. (APB)


The work is described of the field experimental station set up at the Perh Amboy federal plant of the American Smelting & Refinery Co., where it was proved that aluminum chloride vapor can be converted to the stable aluminum hydroxide by introducing steam into the furnace effluent-gas stream and that, at a flue temperature of 600° F., the hydroxide can be converted to aluminum oxide and water. In giving up their water, the very fine particles of the hydroxide explode into much larger particles of oxide whose density is only 2 1/2 pounds per cubic foot. This solid and stable smoke is readily precipitated in a Cottrell treater. (FA)

**1948**


Recovery of benzol at gasworks fell considerably on account of the fuel price increase and high demand for gas. An instruction from the Ministry of Fuel and Power to reduce recovery to not more than 1 gallon per ton of coal caused some works to stop recovery. Coke ovens, not being so instructed, operated to the full extent. Continued demand for sulfuric acid led to the reopening of wartime contract plants, sulfates of ammonia manufacture decreased, and distillation of tar remained active. Fume and grit emission from non-registered works appeared to be increasing because of deterioration of the quality of fuel. An extensive program is in hand to increase the capacity of dust-arresting equipment to meet the increased concentration of grit in flue gases. The problem of spoilbanks reported upon in previous years has been further complicated because the alkali inspectors no longer possess any statutory powers in connection with them. They are, however, working hard to reduce this menace, and an intensive survey was carried out in Scotland. Emission of fluorine from brickworks and pottery kilns, iron works, coal burning in gasworks, and coke ovens was examined, and it was concluded that concentrated fluorine emissions are satisfactorily dealt with under the Alkali Act at hydrofluoric acid and chemical manure works. A possible trouble in England relates to the very attenuated fluorine content of chimney emissions at some brickworks, pottery works, and large coal-burning installations and to smoke from open calcination of some ironstones. Remedial measures, if necessary, should entail heavy charges upon industry. (AI/B)


There has been no relaxation of the standard condition that the layout of new power stations shall be designed to permit the installation of a plant for the prevention of the discharge of sulfur and its compounds into the atmosphere; and that, if so required by the electricity commissioners at any time, a plant shall be installed for this purpose. Observance of the latter part of this condition has not so far been called for by the commissioners at any of the new coal-burning power stations since the war, as they have not received evidence to justify such a course. (FA)


Stringent regulations are in force in Los Angeles regarding the amount of hydrogen sulfide and sulfur dioxide that may be emitted into the atmosphere from any plant operation, and several refineries that have previously burned their waste gases containing a substantial amount of H₂S are compelled to take steps to abolish this nuisance. They are now scrubbing out the H₂S by various methods and selling stripped hydrogen sulfide gas to the Hancock Chemical Co., which will convert it into sulfur in a Simon-Carves sulfur-recovery plant. Fifty tons per day of this gas, which was formerly vented to the atmosphere, will now be made into pure sulfur. (FA)


The Venturi scrubber embodies a new method of cleaning dirty gases on the venturi principle. It has been developed in America, from a standard wet-cyclone-type scrubber in an effort to achieve higher operating efficiency. (APB)
1951


Methods are described for scrubbing flue gases to dissolve the sulfur oxides and for recovering the sulfur from the sulfurous lye. The cost of sulfur recovery and the quantity of sulfur salvable are discussed.


The Fuel Research Station of the D. S. I. R. has been making observations by the “lead peroxide method” on the concentrations of sulfur dioxide in the air near the Battersea and Fulham generating stations. The reinstatement after the war of the flue-gas treatment process does not seem to have resulted in any appreciable decrease in the concentration at Battersea. There has been no reinstatement of the process at Fulham. (APB)


The American-owned carbon-black plant at Stanlow, England, is described. No carbon black is wasted as smoke from the stacks, because of installation of additional recovery and cleansing equipment which ensures freedom from smoke nuisance. White smoke, consisting, largely of water vapor, is discharged into the atmosphere.

1952


The origin and form (gaseous and mist of the fluorine compounds in the furnace gases and their removal by washing in a Peabody gas scrubber) are described in detail. The train of adsorption and filter vessels for the taking of the analytical sample for analysis by the Th(NO₃)₄ method (the zirconazolin method is not accurate) is described briefly. The fluorine content (calculated as HF) of the gases leaving the chimney of the enamel factory was still 0.01-0.02 percent but the absolute quantity was less than that from an artificial fertilizer factory. (APB)


An electrical conductivity vapor-pressure recorder to control the composition of scrubber liquor, so that neither ammonia nor sulfur dioxide was lost with the scrubbed gas, was patented in 1940 by Simon-Carves and the Borough of Fulham. A small plant, in conjunction with this recorder, to treat 1,000 cu. ft. per hr. of flue gas was tested at the Fuel Research Station. Test results are described. (APB)


Review of the methods of handling fume and flue dust at large metallurgical works and the recovery of indium, gallium, selenium, and other trace elements. (APB)


Effluents from gas scrubbers may require treatment before they can be safely discharged to waterways. Large amounts of Ge, Ga, Re, and Se could be recovered from flue dust and smelter discharges. (APB)

The sample is treated with 70 percent nitric acid and heated to destroy organic matter. The residue containing free carbon and insoluble inorganic matter is collected in a porcelain-filter crucible, dried and weighed. Free carbon is then determined by the loss of weight of the crucible on ignition. Representative results obtained from samples collected in urban areas are shown. (FA)

1952


The gases are led from the smoke-producing zone by a duct terminating in a vertical position above water or other liquid contained in a jacketed vessel. The vessel has at least one chimney and is provided with insulation. The space between its walls forms a circulation passage for hot liquid, the gases are not excessively cooled and the chimney draught is adequate. (APB)

DISTRICT HEATING

1921


Important features of a centralized supply of heat to eliminate the smoke nuisance are discussed.

1926


The results obtained by the Smoke Abatement League by issuing a questionnaire to 575 local authorities on their action to reduce smoke by suitable means in the houses constructed by them under municipal housing schemes are discussed. The replies showed that although the majority have installed gas for heating, wash-house boilers, few have installed gas cookers, and hardly any have provided the economical and almost smokeless "independent boiliers," using coke for heating water. Liverpool has given a lead by supplying gas cookers to 80 percent of new houses.

Several municipalities made a good move by providing only a single coal fire per house, by a grate which, when open, heats the room and, when closed, concentrates its heat upon the oven or the back boiler. Hull is trying an interesting experiment with 150 central-heated houses, the furnaces being designed for coke. If these prove a success, 1,000 more of the same type will be erected.

The new Smoke Abatement Bill authorizes local authorities to make bylaws for the reduction of smoke by preventing the erection of new buildings lacking arrangements "calculated to prevent or reduce the emission of smoke." The conclusion is that private houses should not be excluded from the action of such bylaws. (FH)

1945


During the past year, work on district heating by coal, the production of stoker coal in cooperation with Bituminous Coal Research, the problem of smoke abatement, and cooperation with boiler and furnace industries were discussed by the Stoker Manufacturers' Association. (FA)


As reserves of oil and natural gas in America are limited, the most practicable method of smoke abatement appears to be through the development of district heating by steam, irrespective of the size of community. (FA)


Reference is made to a growing revolt of the American public not only against the smoke aspect of the heating facilities but also against the burden of responsibility, the physical effort required, the fire risk involved, and the general inconvenience of the present individual heating plants. This is indicated by the consistent increase in the number of people who have resorted to gas furnaces and oil burners.

This country cannot afford to stand idly by while its valuable but limited oil reserves are wastefully used to do a job that can be done better and more cheaply with its unlimited supply of coal.

The use is suggested of steam heating from a central heating plant fired by coal as a solution of the smoke problem, as well as the convenience aspects of the heating problem. Also such a method of heating would eliminate 27 percent of the national property loss by fire.

Although the magnitude of the construction job involved in central heating systems seems to place it in the realm of impossibility, it is within the limits of accomplishment, as shown by the central heating of defense projects and training centers during the war.

1954


When applied to central heating installations, heat pumps give a higher efficiency than coal-fired boilers, and they have additional advantages in respect of smoke abatement and load building on electricity supply networks. (APB)


The battle of coal to hold its markets against the competition of fuel oil and natural gas is explained. The competition with electricity for cooking and water heating also is mentioned. It is predicted that coal, with the assistance of the coal-carrying railroads, will finance district heating installations in residential areas as the method of recovering its markets. (APB)


The cost of space and water heating in two identically constructed PWA housing projects—Techwood Homes and University Homes—now managed by the Atlanta, Ga., Housing Authority, the cost at the former for 1945 with district steam service being $3.06 per month per unit, or 50 cents per 1,000 cu. ft. and at University Homes with its own plant $3.92 per month per unit or 64 cents per 1,000 cu. ft. (APB)


After outlining the advantages of district heating from the planning point of view—absence of fog, simplification of coal supplies and deliveries, reduction of space needed for fuel storage, elimination of domestic
drudgery, saving of fuel—some of the problems involved are discussed. The determining factor is that of scale, and if heating is organized in terms of towns or districts it is more likely to give satisfaction than on the scale of the single building or even of the single inefficient open fire. (APB)


The scheme contemplates the erection of some 1,500 houses in the estate and the provision of schools, a community center, health center, library, and other public buildings, to all of which hot water would be piped from a central heating station. A description is given of the service to be provided. The average weekly cost per house for loan repayment and running costs will be about 4s. 6d. The advantages of district heating are stated, and diagrams are included comparing the expenditure and the net amount of heat received with the corresponding figures for normal coal-fired heating systems. (FA)

3169. LONDON TIMES. City Free From Smoke. 1946.

If the public health committee of the corporation succeeds in its efforts, office buildings in the reconstructed city of London will all be heated from centrally located generating stations, and the atmosphere will be free from smoke. (FA)


A survey of district heating developments in Czechoslovakia, Denmark, France, Germany, Holland, Italy, the United States of America, and the Union of Soviet Socialist Republics. Progress and prospects have been most rapid in the last and in Germany, where the principal applications have been to the heating of large buildings. The steam and the hot-water systems of heat distribution are compared, and in the large district heating scheme started in Hamburg in 1921, the annual output of which had reached 1,000 x 10^6 B.t.u. by 1941-42, is described. District heating on the Continent has been based mainly on combined heat and power generation, and the success of schemes of this type depends upon balancing the variations of the heat and power loads by one or more of the following methods: (a) back-pressure and condensing sets in parallel; (b) back-pressure and low-pressure condensing sets in series; (c) use of passout steam; and (d) hot-water storage. (APB)


A survey is presented of the costs and the thermal output of a district heating scheme for a typical town of 250,000 inhabitants, using data from the report of the District Heating Sub-committee of the Heating and Ventilation (Reconstruction) Committee of the D. S. I. R. It is concluded that, as compared with existing practice, such a scheme would effect an annual saving of 280 tons of coal per head of the population. (FA)

1947


An unbiased review of the present stage of development overseas and at home, which includes a discussion of the principal factors affecting the provision of such schemes and their fuel-saving potentialities. (APB)


On account of shortage of generating capacity, it is impossible at present for the electric supply industry to take the entire domestic heating load. The implication is refuted that electric heating must compare on fuel costs with solid fuel, and the alleged affection of the British public for the open fire is doubted. Smokeless fuels are not flameless and dustless, coke being a particularly bad offender in this respect. In considering the combination of district heating with generation of electricity, the most efficient system will be that in which electricit is the byproduct and heating the main product. (FA)


A recommendation that district heating by the heat-electric system be provided for the areas of the city of London that have to be rebuilt (covering 220 acres) is subject to such a system being economically adapted during the period of reconstruction to the rate of rebuilding and to any relative improvements in methods of heat production, has been submitted to the Court of Common Council. The estimated cost of the scheme, which is planned in 4 stages, covering 30 years, is £7,084,000, and it is computed that by 1977 there would be a saving of 103,000 tons of coal a year and that the average per therm of the heat supply at the consumer's premises could be reduced from 8d. (with coal at 5s. a ton and having a calorific value of 11,500 B.t.u. per lb.) to 7d., or possibly 6d., per therm, compared with 1s. per therm, the average cost of heat from central-heating boilers costing coal or coke. It is proposed that heat shall be generated and sent out from 2 or 3 power stations situated outside the city boundary and either additionally or alternatively, from the new power station at Bankside on the south side of the Thames. The supply of heat for hot tap water would be served from the distribution mains in a closed circuit through a calorifier in each block. The calorifiers would have sufficient capacity to enable the demand of 5 gallons per head of day population per 12 hours to be met with reasonable diversity. The scheme is outlined in a report. (APB)


The Minister of Fuel and Power was asked what steps he is taking to promote and encourage district heating to save fuel and abolish smoke pollution; and in what areas, to what extent, and with what results schemes for district heating are being promoted or have been approved or put into operation. In conjunction with the Ministers of Health and Works, a committee was appointed in February 1946 to make general recommendations on the practicability of district heating and to examine specific proposals put forward by local authorities and other bodies. Under the aegis of the committee, permission for planning was issued to all local authorities. This has encouraged them to consider the application of district heating to their building programs. Schemes approved by the committee are under construction at Urmston, Salisbury, and Banbury. In addition, 23 other schemes scattered throughout the country have been submitted to the committee or are known to be under consideration. None of the schemes is far enough advanced to establish the costs of operation or what saving in fuel may be achieved. (FA)


The district heating system of Paris, which at present has a total length of 21% miles and is to be extended shortly to 26 miles, is supplied by a back-pressure heating and power plant at Ivry-sur-Seine. At its peak output, this system now allows an annual saving of 40,000 tons of first-grade coal and 224 tons of light oil. When the system has been fully developed to a length of 52-62 miles, it will enable annual savings to be made of the order of: (a) 180,000 tons of first-grade coal and 1,000 tons of light oil, compared with individual heating; (b) 184,000 tons of first-grade coal in the three back-
pressure heating and power plants contemplated. The total economy secured will be 364,000 tons of first-grade coal and 1,000 tons of light oil and fuel oil. (APB)


The installation is strongly recommended of district heating systems by pointing out the advantages derived by their introduction on the Continent and in America. From a comfort and health point of view, background heating should be adopted generally in new buildings. (APB)

1948


Some comments are made on the considerations that should be taken into account in schemes for district heating, and some relevant questions are put. (APB)


A description of the service to 1,700 homes, with a distribution of 77,000 feet of pipe averaging 4½ inches, at a depth of 30-36 inches, the pipe being of steel surrounded by insulation and protected by a conduit of terra cotta. The line loop is about 20 percent of steam delivered to mains. Steam is distributed at 7-10 pounds and the boiler capacity is 230,000 pounds per hour. Plant is in operation from October 1 to June 1 each year, burning anthracite, producing 13,400 pounds of steam per ton of coal. (APB)


Darwen ratepayers have approved a £500,000 district heating scheme, and a bill is to be promoted in Parliament to authorize it. The scheme will provide heat to houses and works. Whereas the average householder spends 5s. 8d. weekly on electricity, gas, and coal, he will be able to have every room heated for 4s. 7d. a week. In 30 years, the undertaking should be debt-free. Pollution by smoke would be reduced; pipeline could be laid over or in the ground. From 65 to 75 percent of coal heat would be available instead of a normal 20 to 30 percent. At the inauguration of the scheme in 1952, heat would be sold at not more than 4½ per therm. This would be reduced as the project developed. (APB)


About 300 installations for heating or cooling purposes in the United States are making use of ground or supply water for the exchange of heat. Although the cost of installation is high, the advantages of low operating cost and the elimination of smoke and dust and operating hazards suggest a promising future. The gaseous heat-exchanger medium is connected to a compressor, and gives off heat to the surrounding media to be heated (for example, radiators for space heating). The cooled gas is then allowed to expand and led by a U-tube through the water well. There it is heated by the well water and leaves for recirculation to the compressor. For cooling instead of heating purposes, the flow direction of the gaseous carrier is reversed in the operating cycle. (APB)


Transport difficulties and poor quality of fuel during the war accelerated development of district heating. An inventory of the installations and tables show details of installations in Denmark (April 1947), extensions of networks, pipe size, number of consumers, kilogrammeters delivered in 1945-46, and distribution of production over the Copenhagen plants. Diagrams of power-station arrangements are given, and fuel econom

ony is shown in tables. Distribution networks are described, and details of heat from a central source to a number of buildings, to satisfy their demands for space heating and domestic hot water. The possibility is considered of raising the efficiency of the use of coal from 15 to 25 percent, which is obtained on the open coal fire, to the 70-80 percent that the proposed system would produce. Saving of coal is the most telling argument in favor of the scheme. Other advantages are: Improvement in domestic heating standards, reduction in dampness, reduction in domestic lighting, a judicious handling of coal and ashes, and reduction in atmospheric pollution. Special emphasis was laid on the combined generation of heat and electricity, and in this connection a short description is given of the three principal types of thermal-electric arrangements. In the first system, the heat is distributed by hot water, but without heat storage. In the second system, heat storage is provided in a hot-water accumulator. The third system, which is developing in the United States of America, uses exhaust steam for the heat distribution. (APB)


The development of district heating in housing settlements in Zurich is traced, and the district heating system developed during the last 3 years in the Brunnenhof settlement described in detail. Plans are given showing the general layout of the settlement, and the plants and the houses and in the central station are illustrated. The effects of various factors on the cost of installation and operation are discussed. (APB)


Gives a brief picture of some of the features of district heating from the industry point of view, and some from the customer's point of view. (APB)


The meaning of the term "district heating" is demonstrated; its advantages and problems are indicated; comparative costs of installing conventional and district heating in houses on new estates are discussed. (APB)


Discusses the problems encountered in designing the Ivery power station near Paris, which is the most powerful back-pressure station in France established to feed a district heating system, including estimation of the steam supply required, and analysis of the most economical type of station making use of existing conduits. (APB)

1948


This meter, with its advantages of interchangeable capacities, is especially adaptable to measuring seasonal loads that vary to the extent that one or more office changes would be required on those meters having a single fixed capacity. Seven different capacity range tubes can be used with the standard meter, furnishing a 4-to-1 ratio. The transmitter utilizes the mercury U-tube principle for measuring differential pressure. A magnetic core operating between two
reactance coils transmits the variations in pressure electrically to the receiver. A sensitive galvanometer picks up the movements and in turn operates the indicating, recording, and integrating mechanisms. As the transmitter and receiver are connected only electrically, greater flexibility of location is secured than with the mechanically operated meter. An exact and convenient “accuracy check” at all ranges can be made by simply closing the meter valves, opening an equalizing valve, and raising a calibrating rod. This, combined with the zero check, practically eliminates the conventional water column test. (APR)


Short history of district heating systems in Denmark from the time of their commencement in 1925 up to the present day. (APR)

3190. Parshive, V. B. [District Heating of Towns From a Distance] Zu Ekon. Topliva (Fuel Econ.), 1949, pp. 6–11.

In view of the growth of Soviet towns and the consequent increasing difficulty of transporting fuel to central “heat and electricity” stations and getting rid of ash, the suggestion is made of siting stations at a distance, close to sources of fuel and water, and supplying hot water to the town for heating and domestic use. An imaginary project is worked out on these lines for a town of 1 million inhabitants with a station 120–200 km. away, supplying water at 150–180°C through a single insulated pipe nearly 1 meter in diameter. This project would show a saving in fuel of 1–3 percent, and the high capital cost would be worth considering in view of the saving in transport and improved amenities. (APR)


Dresden’s municipal heating system by hot water is described. (APR)


A large housing project on Long Island is supplied with steam heat and refrigeration from central plants. (APR)

PROPER FIRING

1879


Not how the smoke from coals can be burned but rather how the coals can be burned without smoke is considered. The means of obtaining the largest quantity of heat from coal are described.

The following chapter headings indicate the subjects discussed: The Constituents of Coal and the Generation of Coal Gas; Gaseous Combinations, Particularly the Union of Coal Gas and Air; Quantity of Air Required for the Combustion of Carbon; the Principles on Which Boilers and Their Furnaces Should Be Constructed; and so on for 21 chapters.

“That marvel of applied science, the regenerative furnace of Siemens” is discussed in detail.

1892


The theory is discussed that perfect combustion can only be obtained when there is present in a furnace an amount of steam in excess of that due to the combustion of the hydrogen of the fuel itself.

Seven essential conditions are listed as follows: (1) An adequate volume of air injected above the fuel; (2) agitation of the air with the gases evolved from the fuel; (3) depression upon and distribution of the mixture in contact with the incandescent mass of fuel; (4) avoidance as far as possible of contact of the mixed gases with the boiler plates; (5) adequate space for the expansion of the gases; (6) the average volume of air admitted over the fuel to be at least a third of the total air supply of the furnace; (7) more steam present in the furnace than that due to combustion of the hydrogen of the fuel.

1893


Considers injurious effect of smoke. Smoke from domestic fires is greater in quantity and more injurious than smoke from industrial furnaces, and domestic smoke is preventable. Discusses defects of existing (1896) methods of heating and cooking, describes improved devices, and suggests desirable legislation. (MIR—Bib.)

1896


Discussion, considering particularly domestic fires as important source of smoke. (MIR—Bib.)

1895


Lectures with illustrative experiments show the harmful effects of impurities. As evidence that fuel can be burned smokelessly, a list of firms operating their plants without smoke is presented. In a comparison of health data for urban and rural areas, the life expectancy was found to be reduced in all age groups for urban dwellers. (USPHS)

1896


The average percentage of soot from 8 good Yorkshire, 2 Durham, and 2 Wigan coals amounted to 6.5 percent of the carbon consumed.

The rest of this elaborate paper concerns the evolution of CO, CO₂, and the heating effects; the comparative cost of gas and of coal fires.

1902


The hearty cooperation of the fireman is necessary to control smoke, for he can easily change a nonsmoker to a smoker.

Detailed discussion is presented and illustrations are made to demonstrate how a boiler can be changed into a nonsmoker without buying any patented furnace.

1903


The problem of smoke is largely one of education.

Denver’s smoke problem is discussed in comparison with that of Chicago, Cleveland, and St. Louis, which have done something about it. Denver has done nothing except frame and pass an ordinance.

No furnace will burn all coals with the same results. A furnace designed to burn anthracite will not do well with bituminous coal and vice versa.

Three efficient ways for hand firing for good combustion and a smokeless chimney are: (1) Coking system; (2) alternate firing; (3) spread firing.

The following new devices and attachments that have been more or less successful in assisting combustion
and preventing smoke are listed and described: (1) Placing arches and walls at certain places; (2) air passages to be introduced under or over the fire; (3) steam jets; (4) downdraft furnaces; (5) stokers, especially the underfeed style.

1906


Good stoking is said to be the main factor in the prevention of the emission of smoke from furnaces. The statement is made that even when so-called "smokeless" coal is used, it does not necessarily follow that smokeless combustion takes place, unless care is given to the proper design of the boiler and furnaces, and unless the stoking is carried out with intelligence and care.

The importance of training stokers is emphasized. If instructional courses for stokers were instituted, and if employers were to give preference to those persons who had been trained properly and could produce documentary evidence of the fact, the result would go far toward mitigating the smoke nuisance, and would, at the same time, effect an enormous saving of money now constantly wasted through the imperfect combustion of coal.

1911


Reference is made to the barbarous combustion of crude coal in a savage and unorganized manner in the midst of the semi-civilization that has been attained so far. The holding of the conference under the joint auspices of the Royal Sanitarian Institute and the Coal Smoke Abatement Society is very appropriate as nothing can be more unsanitary than the sun-obscuring atmosphere in which we arrange to live artificially.

As a remedy for town fog the electrification of the air on a large scale is mentioned as possible but too expensive for dealing with fog caused by imperfect combustion of fuel.

A scientific method of dealing with coal is suggested. This would involve the separation of the solid and gaseous constituents at the mine. The process involving the use of solid fuel should be grouped around a coal field so that the cost of carriage may be small.

The gaseous product can be easily transported to any distance and burned in a scientific and proper manner.

The conditions necessary for the complete combustion of fuel are discussed.

1912


Shows difficulty of supplying air in sufficient quantities. (MIR—Bib.)


Replies to an inquiry sent to 63 firms, whose manufacturers or chimneys had been observed in 6 months, are reported. The general consensus of opinion of the 42 firms that replied was that skillful and careful stoking was of the first importance, although not denying the efficiency of many mechanical devices.

1913


A few fundamental facts are set forth, divested of technical terms, that, if acted upon, would get rid of the greater part of the smoke. The remedy at hand that would not cause expense to the coal user or to the municipality is discussed. There is not a valid argument to resist the compulsory ordinances of the cities that want to be clean. There is not even an occasion for delay in enforcing ordinances, as the cost of temporary equipment is so small, not to mention the returns due to high furnace efficiency.

1914


The new Massachusetts law for abatement of smoke, passed in 1910, has shown conclusively that competent hand firing will absolutely prevent the smoke nuisance. In large power plants using the stokers of this right sort are as good, and in some respects better, than hand firing. The middle-size and smaller plants in and about Boston showed the futility of draft devices in the absence of knowledge and a sense of responsibility on the part of the engineers and firemen. Steam jets have been more of a nuisance than a benefit because firemen have seldom learned their proper use. The whole matter of smoke prevention simmers down in the last analysis to having competent men at the lower end of power-plant operation. From some points of view, it seems rather curious that the profitableness of this course, even quite apart from antismoke laws, has been so little recognized by the owners of power plants.

1913


Describes results of an investigation of a large number of boiler plants in different cities. Gives details of the furnaces and boilers used at these plants and the methods of firing. Also gives the results of tests made at the Government fuel-testing plants at St. Louis, Mo., and Norfolk, Va., to determine the factors governing the production of smoke.

1914


Problem as stated is that of supplying the necessary amount of oxygen. (MIR—Bib.)

1914


Consideration is devoted to transformations of latent heat in fuel into available heat, and of available heat into mechanical energy, together with a study of the devices by which the transformations are effected.

On pages 506-508 conditions for complete and smokeless combustion of fuel are considered, and smoke is defined. Smoke is an indication of incomplete combustion, and hence of waste, and in certain communities is prohibited by ordinance as a public nuisance. It can be avoided by using a smokeless fuel, such as coke or anthracite; or, when the more volatile coals are used, by bringing about complete combustion of the volatile matter.

1914


After discussing the detrimental effects on the health of citizens and the loss of efficiency in heating boilers that accompany the smoke nuisance in cities, the suggestion is made that a law be passed empowering Salt Lake City to create a commission on smoke abatement. There should be a provision that any new all new boilers with more than 75 square feet of heating-surface capacity must be of a type and size approved by the commission before installation. The duties that should be required of such a commission and methods of enforcing the law are outlined.

The successful use of pulverized coal in locomotive operation is described. The engine using the pulverized coal was given severe tests in heavy through and suburban passenger service as well as in transfer runs and never failed to produce the desired results. Methods of using the fuel are discussed.

Some of the advantages analyzed were smokeless, sparkless, and cinderless operation; saving of 15 to 30 percent in fuel of equivalent heat value fired; ability to make use of inferior grades of coal; and automatic firing of boilers.


The subject of smoke, its formation due to incomplete combustion, and its elimination made possible through the new methods of burning powdered coal, are considered.


Burning of fuel is completely the solution of the smoke problem. Sixty-two illustrations show what is not recommended and what might be recommended in the way of boilers and furnaces. Proper methods of firing different kinds of furnaces are shown. Each illustration is discussed briefly.

1917


In answer to the question, what are the three most important things in smoke abatement, a tempting reply would be first, draft; second, draft; and third, draft.

1923


Methods of training engineers and janitors in the proper performance of their duties in the schools of Minneapolis are described. A specialist in engineering work and steam-heating plants was employed to teach the janitors.

Their job is an all-day job, an inside job, and a diversified job. They have to be engineers, electricians, plumbers, and steam fitters. A course of study was prepared that an ordinary man could read and digest and make his own.

The result has been reduced costs, increased efficiency, greatly reduced smoke, and the establishment of a spirit of service among the men. They now think to be a janitor is an important position and are respected in their community.


Formation of dense smoke is due primarily and generally wholly to incomplete combustion of fuel, resulting in improper operation, poor design of equipment, or poor and badly installed apparatus.

The construction and operation of the down-draft heating boilers are described in connection with obtaining smokeless combustion.


Figures for various cities are presented to indicate the tremendous waste and damage that smoke has caused.

Rules of proper firing are discussed.

1924


Describes method used and results obtained in testing furnace to obtain best results with a minimum of smoke.


The combustion control of boilers is dealt with in general and basic facts are given explaining the need for automatic control. Proper methods of control are described for the efficient operation of boilers' heat absorption.

The effects of air excess on operating efficiency are shown in a graph.

1926

3220. ACKERMAN, A. S. E. The Engineering Aspect of the Smokeless Production of Power, Smoke Abatement Conf., 1926.

An interesting review is presented of means of producing power by (a) various methods of coal combustion and (b) alternate methods ranging from burning of fuel to mercury-vapor boilers and sun-plants.

The importance of using powdered fuel, now so largely adopted in America, is urged. This enables a reduction of 25 to 50 percent to be made in the air admitted to the furnaces in excess of the air needed for combustion of the fuel. The loss of heat due to escape of excess hot air through the chimney is thus reduced. Although pulverizing adds 2 percent to the cost of any fuel, it not only enables lower grade (cheaper) fuel to be used but increases by 5 percent the amount of steam obtainable from it. This pulverized fuel may be "semilocokd" by being dropped successfully through two cylinders containing some inert gas heated to 600° and 1,000° F., respectively. The particles thus treated can be stored without deterioration and cannot be made to smoke.

Automatic stoking with pulverized fuel (the furnace feed being controlled by the amount of steam being drawn off through the main pipe to the factory), is not only convenient and economical, but obviates the great difficulty experienced in preventing smoke from hand-fed furnaces in factories subject to rapidly fluctuating demands for steam.

Further, the admixture of pulverized fuel with 50 percent of oil has given as high a ratio as 90 percent of thermal efficiency.

The interesting suggestion is made, that the final solution of the smoke problem may be found in evolution of a substitution for the present furnace-boiler-engine system (which wastes 80 percent of the fuel value) of some such system as the slow combustion of coal in a cell which converts its energy directly into electric power. Before that method is perfected, we may, however, have blown up the universe by liberating atomic energy. (BN)


The root of the smoke evil lies in the proper design and the correct operation of the furnaces where the fuel is burned.

Mechanical engineering, which includes combustion engineering, is not part of an architect's training, and on this account the fuel-burning end of most of the architect's structures has suffered from lack of good engineering design.
A brief treatise is supplied on the subject of combustion of fuels and the effects of air pollution.


Describes the development of automatic combustion control and deals particularly with nature and forced draft regulators and damper controls.


“Cash” standard automatic combustion-control equipment for controlling the rate of combustion by regulation of the rate of fuel, air supply, and furnace draft, with facilities for shifting to manual control, is described.


Describes smokeless combustion of powdered coal in the New Haven power plant at Cos Cob, Conn.

1936


In most American communities, the greatest source of smoke is the hand firing of bituminous coals. Different types of boilers, including oil burners, are described, and various methods of firing them to prevent production of smoke are discussed.

One of the chief reasons for excessive smoke from heating plants is that the heating equipment gets too little attention owing to ignorance and carelessness of owners, managers, and operators. Most oil burners and stokers should be serviced at least once a month by a competent mechanic.

All rules and regulations should be concrete and definite.

Smoke indicators, making it possible for an operator to observe smoke conditions at all times, should be required for new boiler plants. The best type of indicator is one that lights a red light and blows a Klaxon horn when any smoke is made. This calls immediate attention to the condition. To silence the horn, operators usually correct the condition immediately.


Some details are given of how American engineers are dealing with the problem of burning bituminous coal smokelessly in the smaller steam-plant installations.


Describes the primary objectives of a combustion-control system and also the five major factors involved, together with the corresponding methods of regulating them. As the subject is fundamental, the article should be of equal interest to a person owning a plant not fired by oil.

1937


Combustion control and the various systems now available in the American market are considered. The intent is to familiarize the power engineer with the latest equipment now in practice (1937). There are also 23 diagrams showing the various controls. As the term automatic combustion control is now generally understood, it applies to a grouping of air-flow and fuel-feed equipment under the control of a master from which a single boiler or a group of boilers may be controlled. In all systems the master is connected with the steam header to receive the impulse when a change is required in the combustion rate.

Selection of coal for the particular boilers in which it is to be used is an item of first magnitude in obtaining efficient combustion in power plants. The methods used by the Consolidated Edison System, of New York, in testing coal in addition to laboratory analyses and in operating boilers to prevent emission of smoke are described.

1938


In smoke abatement the proper fuel to use in the home and the type of heat plant that should be used to prevent smoke are discussed. The necessity for insuring the purity of the atmosphere, as the purity of food and water has been insured, is stressed.


The elimination of smoke by proper handling and firing of steam locomotives is discussed. Methods of training engine crews to become proficient in the art of operating and firing a steam locomotive are described. Mention is made of the introduction of new types of motive power such as the diesel electric engine. This new type of power eliminates the smoke nuisance.


Various methods are discussed of firing boilers, including those employing automatic methods with mechanical stokers, pulverized-fuel burners, oil, and gas burners.


Various measures for proper burning of coal are presented. The biggest aid in smoke prevention is properly designed furnaces in which regulation of operation can be controlled mechanically to a large degree, especially where inefficient help is used in connection with firing these furnaces.


The rules of the Department of Smoke Inspection and Abatement of Chicago are cited. These rules apply for all types of high-volatile or bituminous coals. Small egg and nut sizes are preferred.

The side-bank method of firing bituminous coal is strongly recommended. If properly carried out this method prevents long flames from being channeled in fire tubes or similar cooling surfaces and smokeless operation ensues. The method is illustrated by diagrams.

1939


Deals with correct methods of firing domestic heating plants, thus avoiding smoke, as well as assuring cleanliness, comfort, health, and economy.

A general comparison is made between the smoke and economy results in firing solid fuels by hand and by means of underfeed stokers, the latter system being favored. Large boiler installations should be mechanically equipped.

In small homes only low-volatile coal should be allowed, unless the “down-draft baffle” is employed.


A successful application of the fundamental principles of combustion as obtained from the studies of ideal fuel beds to the prediction of the operation of the small underfeed stokers requires more knowledge of the combustion process in the stoker itself than has been available in the past. To supply this information, a study has been made of the process of combustion in typical small underfeed stoker. The research has been sponsored jointly by Bituminous Coal Research, Inc., and the Battelle Memorial Institute.


Attention is devoted to the small, isolated plant with either horizontal return tubular boiler, a firebox type of boiler, a down-draft boiler, or a boiler of the Scotch marine type; also the domestic plant with the usual warm-air furnace or the usual boiler or heater of sectional construction.

To eliminate improper, imperfect, and incomplete burning of volatile matter the following three conditions are necessary: Proper quantity of air, the air thoroughly mixed with the volatile matter, and a high enough temperature. Methods of procuring these conditions are described.

1940


Three results of firing methods insofar as smoke is concerned are summarized.


The two difficulties that must be overcome in the smokeless utilization of high-volatile coal in domestic heating plants are: (1) Eagerness with which high-volatile coals ignite and burn and (2) extremely low rates of combustion encountered in domestic heating. No firing method can succeed without the appeal of convenience, economy, and comfort.


Smokelessness with mechanical firing is due to: (1) Gradual feeding of coal, (2) proper proportions of air and coal, (3) proper application of air, and (4) scientifically controlled combustion (broadly stated).

The stoker alone will not insure smokelessness. Other essential factors are: (1) The stoker “as a machine.” It must be properly designed and manufactured. (2) The proportioning of the stoker. The stoker must be proportioned to the boiler and the load. (3) Proportioning of the furnace. The size and proportioning of the furnace are important, also the amount of heating surface exposed and the amount of refractory surface. (4) The selection of control. Automatic controls play a large part in the success of the stoker installations. (5) Actual physical installation. The physical work of the installation must be workmanlike; this requires proper training, experience and competence. (6) Capability of the service organization.

The discussion is limited to hand-fired low-pressure boilers using low- or medium-volatile coal, for heating purposes.

Center ridge method: Starting with a fire that needs attention, coke and live coals are pushed to the flue sheet or rear of the fire box and to the sides, giving a horseshoe shape of hot coal with a comparatively thin center. Fresh fuel is added through the center of the horseshoe from the fire door to within about 1 foot of the flue sheet. The system has the following advantages: (1) Because fresh fuel is in the center of a hot fire it coke rapidly. (2) Fresh coal is not packed against the sidewalls, so that there is no tendency for coke to form an arch, thereby allowing fire to burn out. (3) The mass of fresh fuel settles to the grates as the fire burns, tending to keep tight fire free from holes. (4) Fresh fuel added on a thin part of a fire does not bottle heat at the grate line, reducing the tendency for cinder formation.


Regardless of the method employed in firing, the objective should be to burn the coal economically and without smoke. The construction of a furnace and the setting of a boiler are not guarantees of smokeless combustion in themselves. The starting of a fire and the coking method of firing are described. The principal advantages of the coking method of firing are: Smoke may be more easily abated, and the time intervals between successive firings are longer. Directions for care and operation of boilers, starting a fire without smoke, and banking fires are described.


The writer states that the starting of the fire is the most important part of alternate firing, for one poorly built fire may fill a city block with smoke thick enough to blot out visibility. The proper procedure is to shake out just enough ashes (not coke) to allow air to get through the grate, shove the coal to one side, and add some fresh coal, if necessary; then, place the kindling on the other side and partly on the coal and ignite. The burning kindling gently limits the coal, and smoke is not formed. Using this method, fire can be started with any bituminous coal without creating a smoke nuisance or violation.


Progressive railroads consider smoke abatement as inseparable from fuel conservation. Aside from the economic and health aspect, railroads have another very good reason for constantly campaigning for smoke reduction, and that is, making passenger service more attractive. The most difficult problem is in firing locomotives in roundhouses and maintaining full steam pressure on locomotives while standing in yards and on roundhouse tracks awaiting the signal to depart. Efficient combustion of fuel is one of the most important phases in attacking locomotive smoke problems.


The conical method (which is described in detail) when properly applied to the firing of Pocahontas or other similar low volatile coals, gives excellent results and is most economical.


As a large part of the smoke that begrimes thousands of communities throughout the world comes from small, hand-fired plants burning high-volatile coal, prohibiting the use of this coal in such equipment is the only certain method of eliminating smoke. In view of the fact that 98 percent of the total national coal reserve is of the high-volatile type, the method mentioned is impracticable. It would put an added economic burden on the people who are least able to bear it.

A design principle applicable to all types of hand-fired domestic heating apparatus worked out by the mechanical engineering laboratories of the University of Illinois is described. Smokeless combustion of bituminous coal is accomplished by burning the volatile gases and the fixed carbon or coke in two successive stages of burning. Smoke-abatement officials can best serve their communities by encouraging the development of hand-fired domestic heating apparatus capable of burning high-volatile coal smokelessly; by encouraging an ever-increasing use of automatic equipment; and by enforcing smoke ordinances rather than fuel ordinances.


The operation of modern, up-to-date coal-burning equipment and of plants 20 to 30 years old is discussed. Methods of improving the latter are described. Oil-treated coal can be used satisfactorily with careful attention.

The purpose of designers and operators should be for greater efficiency with the ultimate result of cleaner stacks, better community health, and greater saving of the important national resource, fuel, which we may be forced to conserve.


Directions for care and operation of boilers are given. Each step from starting the fire, without smoke, to banking the fire is illustrated. (11 figs.)


The coking method of firing is described.

The principal advantages of the coking method of firing are easier abatement of smoke and longer time intervals between successive firing. This method is not readily adapted to boilers having fluctuating loads.


Instructions are given for direct firing of bituminous coal by hand for low duty such as residence and apartment building heating plants. If properly carried on, the side-bank method prevents long flames from being quenched in fire tubes or similar cooling surfaces and smokeless operation ensues. Four diagrams showing various operations of the method are included.

3660. ——. Instructions for Burning Low-Volatile (Smokeless) Coal in Low-Pressure Heating Boilers. Man. Ordinances and Requirements, 1941, pp. 55-56. Gives directions for starting a new fire, adding fresh coal, and breaking up solid mass of fused coal so fire will burn the gases and smoke violation be avoided.
The problem of wartime fuel conservation is to bring home to fuel users, large and small, the advantages of proper maintenance and operation of their heating facilities. Elimination of smoke from some 5,000 stacks alone would amount to a saving of 6,000 50-ton carloads of coal annually, or 300,000 tons. The statement is made that for residential heating alone, Pennsylvania would waste 1,280,000 tons of coal during the year (1943) and Illinois and Ohio each nearly a million. Such waste is, in effect, sabotage. Ten ways to save fuel are outlined in the paper. 1944


Details are given of the activities of the National Fuel Efficiency Council. The program of the council is to assist industrial and commercial fuel users to reduce their energy requirements without sacrificing the volume or quality of their processed products or reducing standards for heating schools, churches, apartments, and office buildings.

To cover thoroughly the various points of attack on waste, the National Fuel Efficiency Section of the Fed- eral Bureau of Mines secured the assistance of the industrial engineering committees to prepare the material for use in the active work of the program. For example, the fuel-producing industries and the manufacturers of stokers and other fuel-burning appliances, in cooperation with this section, have set out the prime points of consideration in attaining highest fuel burning efficiency with solid, liquid, or gaseous fuels.

This material is put out in the brief pertinent form of "Quiz Sheets." Study of these sheets will point the way to decreased fuel consumption. This program will tend, in time, to reduce the problems of those interested in smoke abatement.


The Detroit school engineers' in-service training program, which, in addition to promoting the health, comfort, and safety of the school children, effects fuel economy and smoke abatement, is discussed. However, no amount of personnel training will remodel an old, obsolete plant, so in the years immediately preceding the emergency, 51 obsolete coal-burning heating plants were replaced by modern and more efficient equipment. The modernization and rehabilitation of both heating and power plant equipment are advocated as a necessary part of any fuel economy and smoke-abatement program.


Very few city ordinances have attempted to control incinerator and destructor installations. However, when uniform methods of construction are adopted and the licensing of incinerator builders becomes a reality, a big step will have been taken in the right direction in this control.

Properly designed equipment to insure complete, nuisance-free combustion is of paramount importance. A destructor constructed at Wayne University College of Medicine is described. This unit was designed to consume the biological waste from dissection and other materials common to a medical school. The equipment is described in detail.


The substitution of incinerator plants for the reduction plants previously used for garbage and refuse
disposal in Detroit is discussed. Incineration is the
most satisfactory method of disposal. Certain types
of refuse may cause a dense black smoke to emit from
an incinerator plant, and their use should be avoided
or carefully controlled.

1945

Prev. Assoc. America, Man. Instructions on Proper
Firing Methods, 1945, pp. 1-12.

Reasons for the conservation of fuel are given, and
the imperative necessity for using fuel efficiently is
stressed.

Methods for efficient boiler operation are summarized
under 14 points. The work of the National Fuel Ef-
ciency Program is outlined, and a sample is included
of the quiz sheets, termed "Waste Chaser's Quiz
Sheets", dealing with the proper burning of fuel and
the prevention in general plant operation of many times
items of waste that cause more fuel to be burned.

3273. British Medical Journal. Coal and Atmospheric
Pollution. No. 4394, 1947, p. 419.

Various methods used in England to avoid the pollu-
tion of the atmosphere from products of burning coal
are considered. It was estimated that damage before
the war to health, buildings, materials, and agriculture
in Great Britain by smoke, sulfur, ash, or grit was
an estimated cost of $50,000,000 a year. As the more
efficient use of fuel would reduce the amount of ash,
the measures suggested being cleaning of raw coal and
more economic heating devices than the ordinary open
grate.

Discussion included various measures applicable
to large plants which put out large amounts of smoke,
grit, and gases. The pollution by domestic firing could
best be avoided by the use of other fuels than coal,
but for economic reasons this is rarely practical, ex-
cept for the intermittent heating and for cooking.
(JIHT)

3274. Darnell, J. R. Boiler Fireman's Handbook, Xi.
Hand-Firing Methods for Solid Fuels. Power Plant

In this section are included: Most important points
in hand firing; methods of smoke prevention; smoke
as related to type of fuel; smoke-prevention ordinances;
draft required for various combustion rates. (FA)

Smoke Prev. Assoc. America, Man. Instructions on

The mixing of gases in a furnace by some form of
gaseous jet, either air, steam, fine gas, or a mixture
of all of these, is discussed. Smoking stacks still give
evidence that mixing is incomplete. The incomplete
mixing may be due to one or all of the following:
The supply of ingredients is out of balance—usually not
enough air; the importance of mixing has not received
complete acceptance; or the means for mixing are
inadequate.

The various methods of mixing the gases in furnace
operation are described.

3276. Godd, Joseph. Elimination of Nuisances Accom-
panying Incleration. Smoke Prev. Assoc. America,
Chief, on Smoke Abatement and Conservation of
Fuels, 1945, pp. 92-100.

How incinerators can be operated without nuisance
from smoke is explained.

The incinerator is simply a furnace designed to pro-
vide proper conditions for the combustion process of
a material having a low fuel value and a mixture
containing a large portion of incombustible material
or moisture.

To obtain complete combustion oxygen must be pres-
ent in the right amount to combine with the combusti-
bale matter; combustible matter and oxygen must be in the
closest possible contact to effect a combination; and a
high enough temperature must prevail to assure com-
plete combination of oxygen and combustible matter;
complete rapid combustion is paramount to an efficient
and odorless combustion process without nuisance from
smoke and flying ashes.

1946

3277. Bataille, G. S. Correcting Smoke With Auto-
matic Controls. Proc. Smoke Prev. Assoc. America,

A brief account is given of field research work during
the past 5 years at an engineering company. It is
pointed out that to burn fuel cleanly and without
smoke requires: (1) Sufficient air; (2) sufficient tem-
perature rise to this air. The former is easy, the
latter more difficult to obtain. More success was met
with automatic controls affecting the "pull" of the
stack than with the butterfly dampers that restrict the
passageway of the breeching. By constant effort
and research with this method the difficulty of raising
the temperature of the air in the combustion chamber
until the correction of smoke problems became consist-
ent and dependable, was overcome. Examples are
given illustrating that there is as much danger from
to much air as there is from too little air as in proper
combustion and showing how installation of automatic
controls overcomes the difficulty. (APB)

Standardization Committee. Proc. Smoke Prev. As-

The Combustion Standardization Equipment Com-
mittee was formed to acquaint the public with the
simple fundamental rules that govern proper fuel burn-
ing, and the methods applicable to the majority of
installations. A series of pamphlets dealing with the
various types of fuel-burning installations and the
types of fuel in general use would be compiled and
distributed, and it was hoped that the ultimate result
of the committee's work would be that, with its assist-
ance, the enforcement machinery of the Nation would,
in great measure, as far as local conditions permitted,
reach standard conclusions and standard specifications
for equipment to be used in the cities. (APB)

3279. Howatt, J. How to Reduce Atmospheric Pollu-

Rules suggested by the Chicago Department of Smoke
Inspection and Abatement for each State are:
(1) Operate with stack clean at all times. (2) Operate
with minimum overfire draft required to keep stack
clean. (3) Do not burn rubbish at base of stack or
grate of unused boiler with damper wide open. (4)
Clean base of chimney by wetting fly ash before open-
ing clean-out door and dispose of accumulation in
the same manner as for disposal of cinder and ash.
(5) Clean breeching and settling chamber at regular
and frequent intervals. (6) Clean tubes as often as
is practically possible. (7) Never use clean-out doors as
means of ventilation. (8) Close damper as much as
possible when blowing tubes. (9) Encourage the in-
stallation of some means of arresting solid discharge
from stack. (10) Clean roof regularly. (11) Store
sand and other building materials in enclosed space.
(12) Use oil-treated or calcium chloride-sprayed coal.
(13) Encourage scavengers to use covers on trucks to
haul ash and rubbish away. (14) Install equipment
that provides overfire air, combustion controls, smoke
indicators, and/or alarms, and high enough stacks to
insure that no nuisance occurs to neighborhood build-
ings. (FA)

3280. Tucker, R. R. A Smoke-Elimination Program
That Works. Heat., Pip. Air Cond., vol. 18, 1946,
p. 102-104.

The relative advantages of different fuels from the
view point of smoke abatement are discussed and
equipment which burns these fuels with maximum efficiency mentioned. Reference is made to current research on coal and coal-burning appliances. (FA) 1947


In a modern refuse-disposal plant, due to the type of material fired and the use of a post combustion chamber for gases, smoke pollution is negligible. In spite of prescreening, however, a large amount of fine dust is fed to the furnace, and a dust trap of some kind is necessary, usually of the water impingement type which operates effectively on the low gas velocities normally employed. (APB)


A very large percentage of buildings have incinerators that are noncombustible materials. In other buildings this waste material is disposed of in heating furnaces. Few of these units can burn this material satisfactorily unless the fire bed is maintained at an elevated temperature. Disposal of this material results in one of the major sources of pollution which cities experience. Nuisance is also created by industrial plants burning waste and refuse in open lots. This material can usually be burned to better advantage in incinerators or pits equipped with high-pressure jet air as well as by burning in lesser quantities or by disposing of it more frequently. Arrangements should be made to incorporate in the building-code provisions for properly designed incinerators. (APB)


The Minister of Fuel and Power was asked what steps the Government proposed to take to reduce the waste due to loss of heat in smoking chimneys, calculated to be equal to about 10,000,000 tons of coal each year. The reply was that various steps have already been taken to deal with this problem. The fuel engineers of the Ministry continuously visit industrial undertakings to advise on efficient boiler-house practice to reduce heat losses caused by incomplete combustion of fuel. Practical demonstrations are given at works; courses of instruction for boiler firemen have been set up, and active encouragement is given to the development of more efficient fuel-burning equipment. As regards domestic consumption, assistance is given to local authorities in the selection of improved appliances, designed to increase the efficiency with which fuel is consumed. Plans for district heating schemes are being developed. Further progress must largely depend on the expansion of the production of more efficient heating appliances and a greater production and use of smokeless fuel. (APB)


Points out the futility of passing laws against the burning of high-volatile coal. Instead, the effort should be devoted to smokeless combustion of fuels. (FA)


A brief review of the fundamental causes of smoke and the means by which it can be prevented. Results in recent Fuel Research Station publications dealing with smoke from boilers on land and at sea are quoted and used to show that, if properly controlled supplies of secondary air are introduced over the fire, not only can the amount of smoke be greatly reduced, but also the boiler efficiency can be increased. A brief descrip-

tion of the design of the smoke eliminator doors used is given. (FA)


Fuel economy in combined heat and power generation is based on the principle of producing only the strictly necessary output of k-cal. and kw.-hr. Equations show that there is an optimum ratio between heat and power production which must be taken into account to ensure maximum over-all efficiency. (APB)


Discusses the prevention of atmospheric pollution by smoke and fly ash from small boiler plants by training stokers, using proper equipment, and catching cinders for return to the furnaces. (APB)


Complete combustion is the prime objective in a campaign for clean plant sticks. A step-by-step review for coal, oil, and gas revealing the start of pollution and its remedy is given in this paper. (APB)


The properties and components of coal which affect furnace combustion are discussed, including moisture and carbon content, and size and grindability. The information is used to show how to select coal for new and existing plants to obtain smokeless operation. (FA)


The bearing of coal properties on the mechanics of firing and on the behavior of coal in firebeds is discussed and reference is made to the importance of size and screen analysis and of size stability when storage is necessary. Application to new and existing coal-using plants is considered. (FA)


The need for the conservation of fuel is discussed. The efficient use of the fuel available and the avoidance of waste may mean the difference between continuous operation and partial or intermittent shutdowns. The efficient operation of boiler plants is summarized in 14 points, with an explanatory discussion of each. Concerted efforts to obtain careful and proper operation of fuel-burning plants, particularly the small-medium size plants, could easily save at least 30,000,000 tons of coal a year. (FA)


Gives fundamental information on economical ways and means for combating smoke as well as various dust nuisances. Also gives several examples of savings accomplished with proper firing equipment. Discusses elements of adequate ordinances. "T-T-T" refers to time, temperature, and turbulence; "M-O-T-T" to mixture, oxygen, temperature, and time: Two ways of expressing the essentials of complete combustion which are discussed. (FA)


In reply to questions it was said that the reduction of smoke in the air would not prevent fogs, but it should reduce their intensity and frequency. The Fuel Research Station of the Department of Scientific and Industrial Research had studied methods of reducing
the emission of smoke by using fuel more efficiently. Smoke eliminators developed by the station for hand-fired industrial boilers were being marketed commercially. Research on the design of domestic appliances and on the production and use of smokeless fuels was in progress, but this was essentially a long-term problem. The department had also, over many years, organized the measurement of smoke pollution to assess any change in its distribution and intensity. (FA)


To succeed in getting the community to eliminate smoke requires something more than teaching the facts of how the job of burning coal can be done economically and smokelessly. Propaganda and publicity are necessary: to get fuel consumers to want to eliminate smoke. Various ways of carrying on such a program are suggested.

Smoke elimination will be possible only when the fuel-burning citizens refuse to make smoke in the same manner they now refuse to throw their garbage in the streets.


The two primary requirements for combustion are intimate contact between the air and the combustible elements, and a high enough temperature.

Various methods of firing, such as use of the Illinois smokeless furnace and side-bank and nut and slack methods are described. Firing for best results in cold weather and in mild weather operation is taken into consideration, as are methods of kindling and controlling the fire.


Systematic investigations resulted in the development of hand-fired, crossed, nonmechanical heaters and stoves which burn bituminous coals substantially without smoke. Primary air, admitted above the grate, flows across the bed as the coal moves downward from the magazine. A small amount of air admitted above the charge of coal flows downward through the bed and, by oxidation of the surface of the pieces, prevents caking; and makes self-feeding possible with a minimum of poking. At an arch at the point of exit of the gases from the fuel bed, secondary air is admitted through a slot which directs the air toward the bed. In this way, complete mixing of the air with the combustion gases is obtained and the maintenance of a temperature high enough for ignition is favored. (APB)

3297. LONDON TIMES. Health and Home. 1948.

The traditional ways of burning coal in Britain give the domestic consumer far less value for his outlay than the consumers enjoy in America and many parts of Europe. In 1938 British homes and industries released into the atmosphere about 2,400,000 tons of smoke, nearly 600,000 tons of ash, and over 5 million tons of sulfur dioxide. The losses and material damage caused by this pollution cannot have been worth less than £45,000,000. The domestic consumer alone paid out of his pocket some £4,000,000 for the privilege of producing 1,500,000 tons of smoke from soft coal. The cleaning and redecoration of houses and shops necessitated by atmospheric pollution are believed to have cost £5,600,000, while the additional expenditure on laundry and renewal of curtain attributable to the same cause is put at £13,500,000. Many of the Simon report's 39 practical recommendations still wait for official action, but the Ministry of Health last week took the sensible step of forbidding local authorities to install sooty stoves and ovens in their new houses. They must in future choose their solid-fuel appliances from the 69 varieties approved by the Government as efficient; some of these are designed only for burning smokeless fuels, but most can use either soft coal or smokeless fuel of some kind. It is hoped, but not yet required, that councils replacing old grates and stoves in existing houses will also use appliances from the approved list. There is much more to be done, as the supply of fuel and appliances improves, even if the Government stop short of the Simon report's suggestion that "the manufacture and sale of new appliances falling below approved standards should be prohibited as soon as practicable." More could be done even now.

It is strange, for instance, that the standards now imposed on new council houses should not also be applied to houses built or converted privately. In matters of fuel economy and smoke abatement there should be one standard for all new dwellings, without regard to their ownership. (APB)


To develop controls for the control of smoke and smoke problems from any industrial process, it is necessary to understand the process. One industrial process—the combustion of fuels—is discussed and measures to attain the proper combustion of fuels to prevent emission of air pollutants are described.


Discusses the correct burning of fuel to prevent smoke, the function of the chimney, and the part played by locomotives and steamships in atmospheric pollution. (FA)


The lack of engineering data on inincerator combustion equipment is compared with the accumulated and published data on other types of combustion equipment. It is most important, therefore, that incinerator equipment be procured through sources proving years of know-how in all branches of the field of incineration.

The real problem begins with the disposal of commercial and industrial waste in larger quantities. The first approach to the solution should begin with careful consideration of the type and quality of refuse to be incinerated, its moisture content, its B. t. u. value and flash point. After the type of material has been determined, then the type and design of equipment for safe sanitary, and convenient disposal should be considered. 1948


The growing menace of smoke and soot in South African cities, which emanates from domestic and industrial chimneys and from badly stoked steam wagons, is mentioned. Careless slopping is responsible for a large proportion of unnecessary smoke. Methods for attacking the problem are (1) education of public opinion to awareness of its existence, (2) granting of closely defined powers to local authorities, and (3) creation of an organization to give practical advice on better combustion and smoke prevention. (FA)
determine optimum operating conditions and verify reduction of contaminants. A minimum of instrumentation should be necessary for indicating continued activity of the catalyst. The project is still in the experimental stage. (FA)

1953


Data indicate that hand-fired residential coal-burning equipment is a serious source of air pollution.

The Bituminous Coal Research, Inc. program resulted in the perfecting of a new combustion principle, which assures the smokeless combustion of all types of bituminous coal. This principle, termed "cross-feed burning," consists mainly of passing the combustion air horizontally through the fuel bed, rather than vertically upward through the grates. The products of combustion are passed under a refractory arch where secondary air is introduced. Because this secondary air is mixed with the gasses at a point where the temperature is high the combustibles are consumed and smokeless burning results.


Methods of supplying and mixing air with gas before ignition were studied. The limitations of the venturi burner were established and results were applied to flare design. Several burners of varying sizes with a pressure regulating valve to cut them in successively as the gas volume varied were installed. (APB)


A description is given of methods developed at the Fuel Research Station for eliminating smoke from hand-fired burners. During the war, smoke eliminators were developed for Scotch marine boilers and since the war the work has been extended to include various types of shell boiler, including the Lancashire boiler. (APB)

SMOKELESS FUEL

1857

3312. CHAMBER'S JOURNAL. Smoke Nuisance, Vol. 27, 1857, p. 46.

Proposes that the use of gas, coke, and anthracite be made compulsory in London. (MIR—Bib.)

1889


Proposes a scheme for producing from coal a high grade of illuminating gas and a smokeless fuel having a heating capacity 10 percent greater than coke. (MIR—Bib.)


It is almost barbarous to use raw coal for any purpose. The time will come when all our fuel will be separated into two constituents (gas and coke) before reaching our factories or our domestic hearths.

Fireplace for burning both gas and coke or anthracite is illustrated. (MIR—Bib.)

1881


Use of bituminous coal by present methods must be abandoned. Proposes use in half-cooked state arrived at by short process of distillation. Yearly value of
London smoke, which the scheme proposes to convert into useful products, is estimated at £2,125,000. (MIR—Bib.)

1883


1884


1885


1886


1887


1891


1892


1895


1898


1899


3331. Builder (London). London Smoke. Vol. 77, 1899, p. 481. Sir W. Richmond's letter in the Times under the heading "Coal Smoke Abatement," is a very practical one. He records what has been accomplished by the Coal Smoke Abatement Society, which he was instrumental in starting by simply putting the existing law in operation in a number of cases, and he asks for four thousand subscribing members at 5s. annual subscription each, to give the Society an income of £1,000 a year to continue its work. This ought to be feasible, and it is hoped the request will meet with an adequate response. There are two cautions suggested by the correspondence on the subject in daily papers. There are various people who persist in thinking that London smoke is the cause of London fog; an absolute illusion. Under certain circumstances the smoke makes the fog worse than it otherwise would be. London fog arises, under certain conditions of the atmosphere and the earth, in the Thames Valley, and follows the course of that valley. More than once Waterloo Station has been in a dense fog, which continued without intermission to Weybridge (out of reach of London smoke) where the line leaves the Thames Valley, and the air became clear in 5 minutes. The other matter is the foolish cry for the general compulsory use of anthracite to get rid of smoke. Have the people who write letters on this subject ever considered what is the proportion of anthracite attainable, and what would be the effect on its price of a universal demand for it?

1902

3332. Iron Age. Burning Coal Dust Without Smoke. Vol. 70, 1902, p. 10. Experimental outfit tests using Rowe feeder system. Coal is crushed, dried to 2 percent moisture, and pulverized, and the dust is sprayed upward against the arch wall of the furnace. Operators claim great economy of fuel and entire absence of smoke. (MIR—Bib.)
AIR POLLUTION—A BIBLIOGRAPHY

1903

3332. BEFFLEY, GEORGE THOMAS. Smoke Abatement. Engineer, vol. 73, 1903, pp. 852, 874.

Development of the movement for smoke abatement in Great Britain is discussed briefly. A tax on consumption of smoke-producing fuels is suggested. (MIR—Bib.)

1906


To alleviate the smoke nuisance in London, producer gas is suggested for cooking and for heating houses, as domestic smoke is said to form 70 percent of the total smoke in the city.

Gas is more convenient, cleaner, labor saving, and economical for heating and cooking.

Reference is made to a proposal to place a tax on all houses producing much smoke, the same as factory owners are fined. Attention is called to the drastic step in New York City of prohibiting the use of any coal except anthracite.


Results are given with coke as the only fuel used in heating a home. The various advantages of this fuel are outlined. Coke is cheaper than anthracite; radiates a much greater heat; is much more economical than gas, electricity, and special smoke-prevention apparatus; and requires no alteration in grates now in use. It also satisfies the preference of the British public for the cheerful aspect of an open fire and solves the problem of the smoke nuisance.


To clear the atmosphere of smoke it will be necessary to discontinue using crude bituminous coal and use some of its products, such as gas or electricity, or a smokeless fuel.

Hot-water and steam-heating systems will be employed more in houses in the future because of their economy and labor-saving advantages.


It is stated that London smoke due to domestic fires is very large and greatly in excess of that produced by industries, although it is impossible to estimate the proportion due to fires. In fact, if domestic smoke could be abolished, smoke from factories would cause little trouble.

The development of the use of gas for cooking has helped a great deal in the reducing of atmospheric smoke. The use of gas for domestic heating would decrease the smoke still more. However, the question of smoke abatement has had nothing whatsoever to do with it. The gas companies wanted to increase their business, and the consumers found it advantageous to use gas for cooking.

The great desideratum for preventing smoke is a cheap gaseous fuel. No householder will give up his coal fire simply to prevent a smoky atmosphere, but if an efficient and cheap substitute can be found a gradual change will be made. Legislation in this matter is futile.


The cleanliness of the air of Berlin, Germany, is compared with the smoky atmosphere of Birmingham, England, which is attributed to the difference in methods of heating.

The use of gas and electricity, and smoke-consuming processes, where coal is used, are suggested for preventing smoke.

1907

3340. JOURNAL OF GAS LIGHTING. Smoke Abatement and “Coalite.” Vol. 98, 1907, p. 293.

“Coalite” is shown to be not very unlike gas coke. (MIR—Bib.)

1908


The advantages of using briquetted coal rather than coal in its natural state are discussed.

With careful firing, briquets can be used at terminals with a considerable decrease in smoke. Charts of readings and results of tests taken with Ringelmann charts are presented.


Review of inaugural address before Association of Engineers-in-Charge at St. Bride’s Institute, London. Considers steps in smoke production. Advocates gas heating for domestic use. (MIR—Bib.)

1910

3343. BURT, ERNEST. Tendencies of Modern Coking Practice. Colliery Guard., vol. 100, 1910, pp. 256-258.

Suggests that use of coke is the true solution of the smokeless-firing problem, and states that “if soot from any fuel is formed, it is a sign of shortage of air and points to the lack of knowledge... of the main principles of combustion.” (MIR—Bib.)


Discusses physical and chemical action during combustion, and method of formation of smoke. Use of smokeless solid fuel, from which the smoke-forming constituents have been volatilized, is favored. (MIR—Bib.)


Claims gas to be an ideal fuel, cheaper for cooking and heating for short periods, and only 25 percent higher for prolonged heating. (MIR—Bib.)

1911


Discusses relative merits of gas and coal for domestic heating, considering production of smoke and economy. (MIR—Bib.)


Gas is considered a very efficient and satisfactory domestic fuel, and examples of favorable conditions are included. (MIR—Bib.)

1913


Pulverized fuel is considered as a factor in smoke reduction. Traces historical development briefly. (MIR—Bib.)
The results obtained from the use of pulverized coal in locomotive operation may be summarized as follows:

1. Smokeless, sparkless, and cinderless operation.
2. Saving of 15 to 30 percent in fuel of equivalent heat-value.
3. Elimination of ash pits, their cleaning, and expense.
4. Enlarged exhaust nozzle, resulting in smoother working engine and increasing the efficiency of the boiler.
5. Ability to maintain boiler pressure under all working conditions.
6. No special fuel required for firing up, thereby eliminating the danger of fire and explosion.
7. Ability to make use of inferior grades of coal that cannot be utilized to good advantage otherwise.
8. Firing of boiler is entirely automatic.

A discussion is presented on the subject of smoke—its formation due to incomplete combustion, and its elimination made possible through the new methods of burning of powdered coal.

Considered practicability of by-product coking of Utah coal to supply smokeless fuel for domestic consumption.

Lignite and peat are referred to as forming the smokeless fuels of the Northwest, which contains the largest quantity in the United States if not in the world.

As peat was not immediately available, remarks were confined to lignite. Lignite is a free-burning, smokeless fuel, in fact, a very excellent fuel. The drawback in the use of lignite is that in the raw state it averages about 35 percent moisture. This means that when a ton of lignite is purchased freight is paid on 700 pounds of water. The first step then in the broader utilization of lignite is drying it on a large scale at the mine. Fortunately, it is readily dried. Dried lignite is easily pulverized, and pulverized lignite burns like gas, is easily kindled, and is flexible under control. Its utilization would be a big step toward eliminating the smoke nuisance.

Lignite should form the bulk of the fuel burned in the territory around Minneapolis within a comparatively short time, owing to its availability and many advantages.

Mention is made of the lignite briquet as the domestic fuel of the Northwest. It is the equal of the average anthracite, will replace it in all its uses, and sell for considerably less money.

If any real progress is to be made in smoke-prevention work, we must look to other fuel besides coal. Whenever a dollar’s worth of raw coal is burned, approximately 15 dollars’ worth of byproducts are wasted. This gives some idea of how closely related the gas industry is to the smoke-prevention problem when it is considered in the light not only of the conservation of one of our greatest natural resources but of the tremendous waste represented by the loss of byproducts when raw coal is burned and the losses in health and wealth due to the pollution of the air breathed.

After lamenting of the lack of legislation to prevent the burning of uncarbonized coal in domestic grates, the following results are recorded of tests to compare the efficiency of:

(a) Ordinary house coal, and (b) dry gas coke from vertical retorts. These fuels were burned in precisely similar grates and rooms, and a further precaution was taken by the two fuels being exchanged weekly as between the two grates. The cost of coke for providing the same temperature as coal was about half the cost of the latter.

The article then describes and figures the slow-combustion, domestic grate, with which these results were obtained. It is of the “well” type, constructed of firebrick and glazed brick entirely, so that metal is wholly excluded—together, of course, with firebars.

With the object of inducing householders simultaneously to economize on fuel and cease contaminating the atmosphere by their unnecessary smoke, these results deserve the widest publicity.


Atmospheric pollution from smoke is discussed. The soot emission from the domestic fire is about 12 times that of the factory fire for the same amount of coal burned. In 1891 a Manchester Committee showed that the crowded residential district of Hulme, with very few factory chimneys, lost 50 percent more light than Didsbury. In the artisan’s home gas, electricity, or central heating will never replace the open fire, which is the best from the standpoint of health and comfort. The artisan’s open fire is, however, one of the greatest contributors to atmospheric pollution. The practical remedy is the substitution of some form of solid smokeless fuel for raw coal. Coke, instead of being a by-product of gas works, must become one of the principal products.

The adoption by Glasgow Corp. of the Macauley system of carbonization of coal, with a view to supplying gas, smokeless fuel, and hydroelectricity, while providing smoke and costs to be reduced simultaneously, is discussed. On this process the plant is cheap to erect and maintain, the labor charges are low, and the heat used for carbonization amounts to not more than 10 to 12 percent of the calorific value of the coal carbonized. The gas produced forms an ideal firing medium for the present type of boilers as used in Glasgow stations (for generating electricity). The smokeless fuel kindles easily, produces no smoke, presents a fine glowing appearance, and not only emits more radiant heat, but burns longer than coal.

This system, thus, appears capable of enabling corporations to supply cheap electricity for lighting, cheap gas for generating electricity or supplying power for industry, and cheap smokeless fuel (oil and coke) for cooking and heating. Further developments by Glasgow Corp. will be followed with the utmost interest.


Atmospheric pollution from smoke is discussed. The soot emission from the domestic fire is about 12 times that of the factory fire for the same amount of coal burned. In 1891 a Manchester Committee showed that the crowded residential district of Hulme, with very few factory chimneys, lost 50 percent more light than Didsbury. In the artisan’s home gas, electricity, or central heating will never replace the open fire, which is the best from the standpoint of health and comfort. The artisan’s open fire is, however, one of the greatest contributors to atmospheric pollution. The practical remedy is the substitution of some form of solid smokeless fuel for raw coal. Coke, instead of being a by-product of gas works, must become one of the principal products.

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retorts by a modern process that obviates the coke having to be quenched by water. There is an illustration of such a grate, devoid of bottom draft and hence of the "well" type, showing a most cheery volume of smokeless flame issuing from the intensely hot fuel. Not only is there no smoke, but the fire produces more heat at less cost than does soft coal. (BH)

1929


A discussion is presented of the old-fashioned inefficient type of wood-burning boiler and the latest development, which has been specially designed for maximum efficiency from wood refuse, with a minimum of smoke and the elimination of sparks and carbon discharge.


This is an interesting, expert, independent report on a pioneer installation by Glasgow Municipality to produce smokeless fuel by the Maclaurin process, to which so well-merited attention has been drawn.

The main features of this process are that coal in a vertical chamber is heated by combustion of a part of the charge in a chamber that carbonizes the remainder at an average temperature of 450°C. (that is, mostly low-temperature carbonization, although 10°C was recorded at one point); the evolved gas ascends over the upper part of the charge, which is cooled by admission of multiple jets of air and steam to the interior and to the periphery of the chamber and is withdrawn without contact with the hotter zone of burning fuel below.

The report states that "the test has been satisfactory. . . the coke produced was well carbonized. . . and the largest size marketed makes a good fuel for domestic purposes. . . No clinker was produced. . . the installation is economical in labor."

The expenditure of only 2.55 percent of the fuel in carbonizing the remainder compares very favorably with the 8 percent utilized by the alternative method of carbonization by applying heat to the outside of the chamber that contains the fuel.

The form of the report suggests that the smokeless coke product needs gas to ignite it. Experiments with this fuel revealed that it ignited readily if the fire was laid as with ordinary coal. The free burning and radiant heating of this fuel were excellent. (BH)

1930


A discussion is presented on the position of the oil-burner manufacturer to produce good equipment that will work efficiently and not emit any smoke or particles that would cause air pollution.


Investigations proved that coke could be used wherever any other solid fuel was used. It is economical, smokeless, quick steaming, and easy to handle.


It is generally recognized that as long as raw fuels are used as a direct heating agent we will never be absolute users of smoke. Therefore, any substitution of gaseous fuels for raw fuels may be classed as a step forward. The gas industry's expansion will be beneficial to smoke elimination.

1931


In 1923 a special investigation was carried out in Salford to ascertain relative parts played by domestic smoke and factory smoke in atmospheric pollution. It was found that in Salford domestic smoke was the more important factor.

Experiments were performed 1929-30 to test various forms of solid fuel for domestic fires. Vertical-retort coke, a gas coke obtained from vertical retorts by a process that obviates water quenching, was shown to be the best fuel for an all-firebrick open grate. It has a better room-warming effect than either anthracite, best house coal, or Bolsover cobs. It is absolutely smokeless and gives a large amount of radiant heat. It is pleasant and bright and produces no objectionable fumes. Although it is not so easy to light as coalite, it is much more readily lighted than the old water-quenched variety of coke, and is considerably cheaper than coalite. It is the ideal form of domestic fuel for open all-brick grates. Unfortunately, the supply of this coke is very limited.

Alternatives to open fires in buildings, where the latter are impracticable, are considered briefly. Steam or hot-water pipes are not thought to be satisfactory. Panel heating is a recent alternative, but it is not yet ideal. A pleasant and healthy form of heating, which is economical for short periods, is to fix the wall type of electric fire with parabolic reflector near the ceiling. This radiates heat downward upon the occupants, without raising the air temperature of the room unduly. (BH)

1932


Smoke can be prevented by prohibiting the burning of coal in its raw state, but before this can be done, substitutes must be provided that will be more convenient and more economical. It is the duty of health authorities to bring this change about, and in taking action they will obtain all the advantages of better health for the community, improving the amenities of cities and towns, and aiding industries by lowering the cost of heat energy used in production.

1936


The application of coke-oven practice to the production of semicoke is discussed.

1938


The importance of anthracite in smoke abatement or air campaigns is emphasized. The old comparison of a dirty, rusty coal heater with a clean, white, or gas heater no longer holds. Anthracite equipment, from the hand-fired heater to the complete boiler-burner unit is as streamlined and decorative as any other type of heating plant on the market. Not only is this true, but anthracite devices are giving excellent service, with forced circulation hot-water systems, winter-summer hookups, and all types of winter air conditioning. As proof of this, note that most of the prominent boiler and furnace manufacturer and makers of accessories and general equipment are now advertising their devices for use with anthracite, where formerly only oil and gas were featured.

The purpose in outlining the range of anthracite equipment on the market is to remind those charged
with protecting their communities against smoke that they are not confined to 1 or 2 fuels and 1 or 2 types of equipment when they are writing, approving, writing, approving, and installing specifications for plant equipment. Because of the large variety of sizes of anthracite, and methods of burning them every customer may be satisfied and at the same time comply with the most stringent smoke ordinance, for anthracite is in reality a smokeless fuel.


The technical aspects, gas for power boilers, and the requirements for domestic heating requirements of gas are discussed.

Natural gas is available in 40 States, and, to a large extent, no sulfur is produced from its combustion. In those cities where manufactured gas is used, some sulfur does exist in the fine, but the quantity is estimated at about one two-hundredth of the normal production from coal or oil burning. The beneficial effect of gas burning, shown on the health and wealth of the community, is worthy of serious study. The overall, economic savings made possible by gas heat could be illustrated by the comparison between those communities burning a substantial amount of natural gas and those using other forms of fuel. The gas industry is whole-heartedly behind the aims of smoke prevention. It feels that the inherent ideal characteristics of its fuel are contributing an important share in the ultimate achievement of smoke prevention.


The smoke problem in Louisville is not concerned with manufacturing plants, railroad operations, commercial operations, or large private homes and apartment houses. If all these groups are made 100 percent satisfactory, there is still the problem of the majority of home owners in the lowest income brackets who do not have furnaces and cannot afford to dig cellars and install furnaces or stokers. The economic solution for this class of users constitutes the backbone of the whole abatement problem. In Louisville it is estimated that the private homes produce 60 to 65 percent of the total smoke.

Dissemination of information to arouse public opinion to support a modern smoke ordinance and making a smokeless fuel available for the lowest income-bracket home owners, at a price as cheap or cheaper than the soft coals now being used, are suggested as a solution to the smoke-abatement problem.

1939


Reference is made to the crisis in the Illinois coal-mining industry due to the rapid increase in strip mining and on to the increasing concern about atmospheric pollution.

The activities of the Illinois State Geological Survey directed toward developing smokeless fuels for ordinary heating equipment and improving Illinois coals so that they may be burned more readily without smoke in special appliances are outlined. The proposed activities of the Survey are directed toward the acquisition and assembling of knowledge that will reveal the extent and availability of the mineral resources, as well as the efficiency and extent of their utilization.

At the time the article was written there was no definite assurance such a program of research, as outlined, would be authorized, 3370. HERLEY, HENRY F. Preparation and Quality Control of Steam Coals. Proc. Smoke Prev. Assoc., 33rd Ann. Conv., 1939, pp. 60-71.

Consideration of coal preparation from the viewpoint of smoke abatement includes the application of heat, generally known as destructive distillation, and the application of a physical treatment to bring about beneficiation. One of the greatest aids to the reduction of smoke is a preparation program that will yield a uniform product in ash and sulfur, and free from minute sizes. Various methods of coal preparation are discussed.


Reference is made to the advantage enjoyed by low-temperature coke over other solid fuels for house heating.

Low-temperature cokes meet the requirements of the situation with respect to its absolute smokelessness, convenience and ease of control, general desirability as a solid fuel for hand firing in domestic heating plants, hot water heaters, fireplaces, and in small industrial plants, such as bakeries and laundries in populous areas.

A low-temperature coke, Disco, is said to be satisfactory as a smokeless fuel but limited in quantity. Details of the manufacture of this fuel are given. The most interesting development from research to simplify the process is the discovery of its general applicability to any bituminous coal. The reduction in cost of operation and maintenance resulting from the successful operation of the Disco plant for 5 years indicates the general application of the process to the production of Disco for the smokeless domestic heating market.


Problems of providing sufficient air and furnace volume for smokeless combustion and certain conclusions based on experience and study are presented. Anthracites, because of their chemical composition, are inherently smokeless under all conditions of use. Smoke production from fuels of lower rank depend upon the characteristics of each fuel and on the conditions under which it is burned.

1940


All smokeless fuels can smoke under adverse conditions; it is only through a thorough understanding of the characteristics of the various fuels and the different types of mechanical fuel-burning equipment that a satisfactory smoke-elimination program can function successfully.

The four main classes of oil burners are the vaporizing, vertical rotary, gun, and horizontal rotary. Each type has its own individual installation problems to provide efficient, smokeless operation. These problems are presented and discussed.


The use of smoke index, as a research tool in the laboratories of the Illinois State Geological Survey, has established that the low-temperature portion of the volatile matter is the smoke-producing ingredient in bituminous coals; that the natural concentration of fusain in Illinois deduster dust is adequate to result in the production of a smokeless fuel when briquetted without binder; that percentage volatile matter in a
coal may be a misleading index of smoke content; that
the banded ingredients of Illinois coal possess widely
different smoke index; that the washing of coal does not
remove the smoke-producing ingredients of coal; that
dry coal has a noticeably lower smoke index than
damp coal; that slightly weathered coal, likewise, has a
lower smoke index than corresponding freshly mined
coal; that a briquet made without binder at very high
pressure, because of its high density, burns in a manner
similar to anthracite coal; and finally that many of
the commercial natural smokeless coals possess a rela-
tively high smoke index.
1941
3375. Orgain, Stuart, and Edwards. Phil. Does Oil
Treatment Affect the Burning Characteristics of
Conv., 1941, pp. 91-93.
The advantages and disadvantages of the treatment
of coal with oil are discussed. In most cases oil on
coal definitely changes the results obtained in the aver-
rage 8x box. Operation of equipment must be con-
trolled more carefully to offset the increasing tendency
toward caked fuel beds, coke trees, smoke, fly ash, and
increased coal consumption—the last being the result
of the first two.
1943
3376. Rose, Harold J. Smoke Tendencies in Coals of
Various Ranks. Proc. Smoke Prev. Assoc. America,
The correlation of the smoke-producing tendencies of
coal, with their rank and analysis, is discussed as a
general guide for coal selection.
Anthracite is completely smokeless under all burning
conditions, regardless of equipment, firing method,
burning rate, or carelessness on the part of the user.
The amount of smoke produced from bituminous and
lower rank coals depends not only upon the character-
istics of each fuel but also on the conditions under
which it is burned.
1945
3377. Russell, Charles C. Domestic Heating With
Coke. Manual Instructions on Proper Firing Methods,
The qualities of byproduct coke as a domestic fuel
and equipment and methods for its economical and
efficient use are discussed. Coke is a smokeless fuel,
and the advantages of its use as a domestic fuel are
stressed.
3378. Singh, A. D. Trends in Development of Smoke-
Recent trends in the production and utilization of
smokeless fuels are discussed.
The trends of smokeless-fuel production appear to be
in the complete gasification of coal aimed at the
production of high-B.t.u. gas, preferably under pressure,
and in low- or medium-temperature carbonization of
coke with smokeless briquettes or coke and gas as the
final products.
1947
3379. Azais, — [Utilization of Cokes for Domestic
Heating.] Te Congrès internat. chauffage, ventilation
t et conditionnement (Inst. Cong. Heat., Vent., and
To ascertain the best means of utilizing native coal
products for domestic heating, the mines of the Nord
and Pas-de-Calais made arrangements with manufactur-
ers of domestic heaters to try domestic appliances
with smal coke and semicoke unsuitable for industrial
purposes. Tests were made to study ignition and slow,
rapid, and delayed combustion with these fuels. They
were found to be mechanically as good as anthracite,
rather more care being required in removal of clinker.
(ABP)
3380. British Standards Institution. Gas-Cooking
The selection and installation of gas-cooking appli-
cances are considered. Information is presented dealing
with types of cookers, sitting and space required, capac-
ity, ventilation, and fire precautions. Examples of
various types of cookers are illustrated in an Appendix.
(ABP)
3381. Czezens. — Gas for Central and District Heat-
The economics of gas as a medium for producing
heat, both from the national and the consumer's point
of view are considered. As an example, the heat re-
quirements of a factory building and the economics of
an electric thermal plant are compared with those of a
gas-fired boiler plant. (ABP)
3382. Cross, D. C. Replies to the Opening Survey: (1)
The program of reconstruction and extensions in the
gas industry, which will make smokeless fuels available
for all requirements in the country, is discussed. The
needs for production of modern domestic gas equipment
is stressed, and whether complete gasification of coal
is likely to develop or whether a balanced consumption
of gas and coke will secure the best economy, including
how much more gas coke we can expect in the next 10
years, is considered. The advantages of replacing raw
coal by smokeless fuel are enumerated, and the
use of coke and gas for central heating are discussed.
Each of the services, gas and electricity, has its own
advantages in certain domestic uses and should be
developed fully to create a correct balance among all
fuel services for the ultimate benefit of the public (FA)
3383. Dale, W. W. Replies to the Opening Survey: Elec-
On account of the shortage of generating capacity,
it is impossible at present for the electric supply indus-
try to take the whole of the domestic heating load.
The implication that electric heating must compare on
fuel costs with solid fuel is refuted, and the alleged
affectation of the British public for the open fire is
doubted. Smokeless fuels are not fumeless and dust-
less, coke being a particularly bad offender in this
respect. In considering the combination of district
heating with generation of electricity, the most effi-
cient system will be that in which electricity is the
by-product and heating a main product. (ABP)
3384. Hicks, D. Anthracite and Dry Steam Coals—
Natural Smokeless Fuels. Nat. Smoke Abatement Soc.,
1947, pp. 52-54.
The quality, marketable grade, and past, present
and future outputs of anthracite and dry-steam coals
from the South Wales coal field and the classes of con-
ersers of anthracite are discussed. The disposal, briquetting,
and carbonizing of dry-steam coals and the produc-
tion of hard coke are considered. From the hash angle
of smoke abatement, a satisfactory result is obtained;
however, these classes of coal are used because they
are naturally smokeless.
3385. Lesher, C. E. Recent Progress in Smokeless-Fuel
Meet., 1947, pp. 91-96.
The relative values of various fuels in the future
energy requirements of the United States were dis-
cussed, and it was stated that neither petroleum nor
natural gas could replace coal in any considerable ex-
tent. Reference is made to the research undertaken
by Pittsburgh Consolidation Coal Co. in making syn-
thetic smokeless fuels from coal and to the existing
and proposed plants of Disco Co., Pittsburgh, for the
manufacture of the smokeless solid fuel known as
Disco, which is a low-temperature coke in convenient ball-form produced from coal fines and slack, requiring only low-graduating coals, and yielding a tar by-product rich in tar acids. Also the growing use of powdered fuel was described. (APB)


The contribution that gas coke can make to the program of efficient and smokeless heating as outlined in the Simon Report is discussed. In connection with its acceptability as a domestic fuel, the design and production of properly constructed appliances, size grading, storage, quality, and ash content and from the supply aspect, the quantity and price of the available coke are considered. (FA)


Papers presented at the 14th Annual Conference of the National Smoke Abatement Society are surveyed. The carbonizing industry, which is doing more than any other industry in helping to rid the atmosphere of smoke, is defended, and its policy in modifying coke properties so that it may be used in both new and old-type grates is discussed. More than twice as much coal is required to provide heat by generating stations as compared with coal processing at a gasworks. A plea is made for the retention of the open smokeless-fuel fire. (FA)

J918


Dwellings in the postwar estates of Salford are being provided with grates designed especially for burning smokeless fuel. Compulsory use of smokeless fuel is being considered. (APB)


An air-pollution committee has been appointed by the National Coal Association (United States of America) to initiate an educational campaign, with special emphasis on economical burning of solid fuels to eliminate smoke, and to deal with elements other than coal that are present causes of pollution. (APB)


The increased use of smokeless fuel for domestic heating is urged. One unfortunate result of the fuel shortage is that prefabricated houses, equipped with new appliances in which smokeless fuel should always be used today, are adding to the domestic-smoke nuisance. (FA)


A plea for the use of smokeless fuel. (APB)


The new Salford Corp. Act makes it illegal to supply coal to any part of the postwar housing schemes, and the tenants will have to use gas, electricity, coke, or other smokeless fuel for all purposes. (FA)

1949


The properties and safe handling of butane and propane fuels—two types of liquefied petroleum gas used throughout the United States—are discussed for the information of the rapidly increasing number of domestic and commercial consumers of these fuels.


The displacement of wood by coal and the resulting complaints regarding the pollution of the atmosphere by smoke are discussed briefly. The various smoke-abatement committees and their attempt to reduce the atmospheric pollution are described.

The domestic open fire produces more smoke per ton of coal burned than any other appliance in general use about one-half of the smoke pollution arises from these appliances, although they consume less than one-fourth of the total coal used.

Although the problem has been studied by many investigators, there is no satisfactory technique of controlling an open fire that will burn bituminous coal without producing any smoke. The use of more coke in place of coal has greatly reduced the amount of smoke. There is no method of reducing the amount of pollution by sulfur gases from each ton of fuel burned in domestic appliances, whether the fuel is coal or coke. Substitution of gas for solid fuel would avoid pollution by smoke and grit and would reduce pollution by sulfuric gases to a negligible amount. Gas and electricity, however, are too expensive for continuous heating in the average house.


The work done by the Birmingham Corp. Gas Department, described at the November meeting of the Institution of Gas Engineers, is discussed in relation to the experience of the Severn Valley Gas Corp., Ltd. It is shown that the behavior of a solid fuel in the domestic grate is largely governed by its ignitibility and that a low-ignition temperature is desirable for reasons which are given. The various combustion characteristics of some widely different fuels such as anthracite, Coalite, Shetland coke, static and nonstatic coals, and blended coals are studied by a series of radiation tests. Factors influencing combustibility that are considered include (1) excessive graphitization, (2) steaming, (3) maturity of the coal, (4) size grading, and (5) bulk density. It is concluded that the results obtained at Birmingham are in accord with those obtained by the staff of the Severn Valley Gas Corp., Ltd., and Gas Consolidation Ltd., in their independent demonstrations at various times since 1934, and the Birmingham recommendations are confirmed. (APB)

1950


The Coal Utilization Joint Council wholeheartedly supports smoke abatement. Although modern large-scale combustion equipment, when properly handled, gives little smoke and certainly no excuse for discharging smoke into the atmosphere, small-scale domestic appliances are in an entirely different position. The total elimination of domestic smoke can be achieved only by using gas, or by burning only forms of solid smokeless fuels. Too hard pressure for smokeless zones may discredit them. It would be better to convert the smokeless fuels as much as possible on new townships in which the houses could be equipped from the beginning with suitable appliances.
In the meantime, in other areas, the procedure to follow would be to accept a less stringent standard than the absolute smokelessness required under the present controls.

**3398. MINING CONGRESS JOURNAL. Smokeless Fuel, Vol. 36, 1950, p. 69.**

It was announced recently that in the future smokeless fuel may be made from Illinois coal. Experiments have been conducted during the past year on metallurgical coke blends prepared from Illinois coal.

A new market for more than 1,000,000 tons annually of Illinois coal has been found as a result of research work conducted in the blending of Illinois coals with Pocahontas coals for the manufacturer of metallurgical coke.

1951

**3399. COLLIERY GUARDIAN. National Smoke-Abatement Society, Vol. 183, 1951, p. 363.**

At the annual conference of the National Smoke-Abatement Society, September 26-28, 1951, the smokeless-fuels position was discussed. It was pointed out that the modern types of open grates and stoves gave save, should be exempt from any kind of fuel but were much more efficient with coke than with bituminous coal. The domestic market, which has the last call for supplies of coke, should have the first. Space heating by solid smokeless fuel would be greatly helped if the National Coal Board would supply coal at a cheaper rate to the carbonizing industries that produce smokeless fuel and make those domestic consumers who insist on burning coal in the raw state pay extra. When the evil of air pollution is overcome, public opinion, doubtless, will be amazed that their forebears were content to live in a country where nearly 2½ million tons of dirt and soot were discharged yearly into the atmosphere, to be inhaled into the lungs, ruin the architecture, and greatly increase labor.

When a reform has once been accepted, the previous evil has always seemed incredible to future generations.

1952


Manufacturers claim that they must use high-volatile coal to get proper effect on brick surface and therefore should be exempt from the smoke law. Investigations in Canada and in the United States indicated that this claim was not valid.

When the St. Louis ordinance prohibiting the hand firing of high-volatile fuel was first passed, the ceramic industries would not have to be exempt from this provision because high-volatile coal was necessary for the firing of their product.

It was found that the kilns, when hand fired, smoked badly during the "warming-up" period, that is, from the time the fire was first built in the cold kiln until the temperature reached approximately 1,000° F. After this point, continued firing with high-volatile coal seemed to produce no smoke, at least none that could be classified as objectionable. This was, of course, because all the material on the inside of the kiln had become so hot that volatiles were almost completely burned before escaping into the atmosphere.

Accordingly, it was recommended that a low-volatile smokeless fuel be hand fired until this 1,000° F point was reached. Not only did the clay people feel they could fire this kind of fuel without smoke, but they found, much to their surprise, that they got the kiln up to temperature in a much shorter time than was required when they fired the high-volatile coal. The saving of time on each kiln of ware more than paid the difference between the high- and the low-volatile coal.

With different types of kilns and different solid fuels, it may be necessary to do a little experimental work to determine the kiln temperature at which the changeover from smokeless coal to smoky coal could be made. It is believed that after the moisture has been driven out of the ware, and it has reached sufficient temperature, high-volatile coal of nearly any kind can be fired without objectionable smoke.


The Coal Producers’ Committee for Smoke Abatement was organized by a group of progressive producers and shippers of bituminous coals.

Competitors, with oil, gas, and low-volatile coals to sell, featured the smokeless operation of their products and were prone to attribute all smoke, dirt, and much ill health to bituminous coals. This made it necessary for bituminous coals and coke for the performance of their coals, where criticism was justified, and to instruct users and the public, generally, in the proper and efficient utilization of the coals.

The sponsors of the Committee knew that many millions of tons of their coal were being burned without creating air-pollution nuisances; therefore, they believed that the same results could be obtained with 100 percent of their products.

The Committee's activities have included surveys, education, engineering service, cooperative activities, and research and technical studies.

Surveys disclosed the sources of the problem and indicated many answers for the coal industry. Education was found to begin at the management level, whether civic, industrial, or political. An ordinance is not the complete answer. The human element is so important that future plans include education as a prime essential and No. 1 on the list.

These plans include (1) education; (2) surveys in additional cities; (3) plant inspections to demonstrate economy and efficiency of new equipment, and/or modifications to owners; (4) correct application of equipment and fuel utilization; (5) improved performance of take vessels; (6) application of new equipment to existing equipment, auxiliaries as required on others; (7) small steam-plant betterment programs; (8) reappraisals for further reduction in emissions of programs where base values have already been established and on record; and (9) continued cooperation of Committee and various smoke departments on difficult problems.


The five articles on the various types of solid smokeless fuels recently published in this journal are reviewed critically (APB).


The development and reception of the smokeless zone in Manchester, which came into force on May 1, 1952, is given briefly in newspaper extracts. (APB)


By far the greater tonnage of the steel industry is produced in open-hearth furnaces. In the United States there are more than a thousand open hearths, varying in size from a few tons capacity to more than 500 tons and producing a wide variety of steel.

By nature of the operation of an open-hearth furnace, dust is discharged from the stack. A series of pilot-plant tests, conducted by one of the steel companies, is described. These tests were made to find some practical, reasonable method of reducing the amount of dust discharged from an open-hearth stack. The tests included representative units of all types, except the bag filter and washer. Tests were made on the following six units: Sonic unit with type "D" rotorcone, sonic unit with type "W" rotorcone, multicone, Trion
precipitator, type “N” rotoclone, Impingo pebble filter. Each unit is discussed in detail.

The tests did not solve the problem, and no practical, reasonable, method of satisfactorily reducing the amount of dust from an open-hearth stack was developed. It was concluded that the only method that would do the work would be a high-voltage electric precipitator.

SMOKELESS HEATERS OR FURNACES

1888


Describes heating system of Washington University, St. Louis. Cites experience with smokeless furnaces, all those tried having proved unsatisfactory as regards economy. (MIR—Bib.)

1898


As most of the plants in London used “smokeless Welsh” coal, the Welsh coal strike created much disturbance in England. Furnaces were constructed for Welsh coal, and bituminous fuel could not be burned without smoke until furnaces were altered. Thus, the smoke problem was quite acute.

An advantage of externally fired boilers employed so widely in America is that a steeply sloping stepped grate may be used under them and fed by some mechanical means on the cocking system, and the fuel may be made to travel quickly enough down the slope to prevent an excessive flow of air coming through the grate. English boilers are usually fired internally, and the problem of economical mechanical stoking is much more difficult than in America, because a fire cannot be made to travel and pack closely upon the grate, no matter how the bars lift and creep. With gravity to aid, such control is feasible, and if anything brings about the use of water-tube boilers in London probably the question of mechanical stoking will have as much as anything else to do with it.


The principles, construction, and operation of the furnace are discussed. The principle of operation of this automatic mechanical furnace is immediate, rapid combustion by means of a coking and a coke-burning furnace, in which the volatile gases are instantly and continuously consumed with the carbon or coke, producing complete combustion and high temperature, with virtually no smoke.


Illustrations show the design and construction of a smokeless furnace containing all the necessary elements for smokeless combustion and high economy. It is claimed that this furnace is constructed on correct scientific principles and that it will both burn smoke and consume any kind of coal without smoke, with any kind of chimney draft, while being very economical.


The Hawley downdraft furnace is described. It makes virtually no smoke because the combustion conditions are nearly perfect. The furnace is economical because (1) no fuel or capacity is lost during the cleaning of fires; (2) no fuel is lost in the ashpit, as any coal not completely burned on the upper grates is caught on the lower grate and consumed; (3) no cold air is allowed to come in contact with the heating surface of the boiler; (4) the hydrogen in the coal is worth 4.28 times as much as the carbon, pound for pound; and (5) the circulation of water in the boiler is increased by the Hawley furnace.


Illustrates and describes the Walker furnace as applied to boilers, puddling and heating furnaces, garage destructors and locomotives. Gives results of tests. (MIR—Bib.)

1899


Furnace designed by James Lethem, with specially constructed door, so that air must travel over large heating surface before reaching the fire. (MIR—Bib.)

1901


Discusses the design of a few types of furnaces, showing how they promote or fail to promote smokeless combustion. (MIR—Bib.)

1902


Discusses scientific construction of furnaces and boilers and correct conditions of combustion, as outlined in recent papers on the subject. (MIR—Bib.)


The most effective work that can be done in an endeavor to aid in the prevention of smoke is to educate the public and encourage the development of improved furnaces.

Experience in Cleveland has shown that abatement of the smoke nuisance has been accompanied by a reduction of 15 to 25 percent in coal bills; reduced cost, as well as the interest of manufacturers in the welfare of the city, has aided in the efforts to purify the atmosphere. This economy is the result not only of the more complete combustion of the fuel but is due in part to the improvement in boiler efficiency by reason of the diminished fouling of the flues by soot.

There is little doubt that no more powerful incentive toward the abatement of the smoke nuisance can be offered than a demonstration of its fuel economy, and this has been fully demonstrated by the results in Cleveland.


The real secret of smoke prevention is to obtain such complete combustion of the fuel, including the gases generated in the process, that there will be no smoke to consumer; that is, smoke is due to imperfect combustion through improper design or operation of the furnace. When new boiler plants are being installed a type should be chosen that will suit local conditions as nearly as possible and will give comparative freedom from smoke and effect enough saving in the coal bills to compensate for any possible increased cost in construction. Many old and inefficient boiler plants may be replaced by new ones, with a like saving, while often some simple and comparatively inexpensive change in or addition to a furnace will stop clouds of smoke. The human element in furnace operation is of the utmost
importance, since so much depends upon feeding the fire evenly and keeping it uniformly clean and free from clogging. In fact, so important is uniform firing and constant attention that many large plants are provided with automatic devices for feeding the coal and cleaning the grates. Many opponents to smoke prevention claim that it will work a hardship on manufacturers and force them to accept useless devices. But in the long run smoke prevention usually will pay for itself; in any event no manufacturer has a legal, much less a moral, right to conduct his business to the injury of others. Unquestionably, many useless devices have been foisted upon owners of boiler plants, and many honest mistakes have been made by those seeking to abate smoke. The multiplicity of furnaces and of furnace attachments for which smokelessness is claimed is confusing to a novice, and when the wheat has been separated from the chaff there still remains the problem of selecting an apparatus adapted to the special and local needs of each plant. The only safe course for the manufacturer is to obtain and follow competent, disinterested technical advice.

1906


Describes Kent’s “wing-wall furnace.” (MIR-Bib.)


Furnace was designed by Horsfall Co. Smoke-consuming arrangement “consists of a separate blowers and air injector over the grate, which draws its air supply through the hollow cast-iron baffle fixed behind the firing front.” A regulated supply of heat is thus delivered in the midst of the heated gases. “Applicable to every class of boiler, and specially adapted for burning small and dirty coals.” (MIR-Bib.)

1908


Smokeless design, claimed to be entirely feasible and economical, depends on the following principles: Uniform supply of fuel, properly distributed air supply, capacity to develop high temperatures, and retention of burning gases within high-temperature zone till combustion is completed. (MIR-Bib.)

1912


Antismoke nuisance agitators urged the adoption of gas furnaces for reheating at Sheffield, but several manufacturers said that smoke was necessary in certain processes and that its skillful use by experienced workmen was instrumental in maintaining the famous quality of Sheffield steel. The carbon quality of the steel depended on having a smoky flame in the reheating furnaces, a matter of the highest importance, as otherwise the surface of the steel would lack the carbon, which conferred specific properties, and would be comparatively useless. The higher the carbon content of the steel, the greater the quantity of smoke that would be required.

1916


Some important statistics that show the trend of the times and the shaping of public opinion in its attitude toward the smoke-abatement problem and the serious contribution to this problem that comes from the apparently harmless heating fires of the average American homes are indicated briefly.

The important developments that have taken place since the first invention of the furnace are reviewed, from the time of War up to the present time, in an effort to solve the problem of smokeless burning.

1929


The fundamental requirements of a smokeless boiler for heating work are (1) sufficient grate area and fuel chamber, (2) a large combustion space, (3) an evidence of heating surface, and (4) a provision for the admission of preheated secondary air.

1930


The true elements necessary in the design of a furnace to prevent it from contributing to the smoke nuisance are: (1) Furnace volume, (2) furnace share, and (3) furnace construction.

1938


Seventeen reasons are listed to show why 90 percent of the 14,000,000 central heating systems in homes or buildings in the United States need modernization, repair, or replacement. Smoke is unnecessary and uneconomical. It has no defense and can be eliminated by the use of proper equipment.

1941


Describes the equipment used and the results obtained in the application of a new process designed to make possible the combustion of Illinois coal of small-egg size without smoke in hand-fired furnaces and gives the results obtained by smoke-measuring devices when used in connection with the combustion of a new commercial briquet made from Illinois coal fines rich in fusain.

A new concept, denoted by the term “smoke index B,” which is analogous to the concept previously reported denoted by the term “smoke index,” is introduced to compare (1) the total amount of smoke liberated per pound of coal in a furnace with a smokeless burner with that liberated in the conventional furnace and (2) the amount liberated per pound of coal by each of various coals in the conventional furnace.

The data presented show that if Illinois coal were composed entirely of volatile matter it would have a higher B. t. u. than if it were composed entirely of fixed carbon. As the ratio of volatile matter to fixed carbon in Illinois coal ranges from about 0.7 to 1.0, evidently, to burn Illinois coal efficiently, means must be employed whereby combustion of volatile matter is made as complete as possible.

This may be done by using the invertible grate, the principle of which was studied during the last year by the Illinois Geological Survey. This grate may be used in various types of hand-fired furnaces. By its operation the fuel bed is inverted immediately after hand firing, so that the volatile matter liberated from the freshly fired coal is consumed as it passes upward through the overlying layer of glowing coals. Data shows that small egg-size Illinois coal, when burned in an invertible grate, liberates less smoke than the average liberated by low-volatile coals.
CONTROL OF AIR POLLUTION

After the discovery reported last year that the very fine sizes of Illinois coal with their natural concentration of fusain, when briquetted without a binder, liberated only a small fraction of the amount of smoke produced by lump coal from the same mine, a prominent coal operator is now producing large quantities of such briquets on a commercial scale. When these briquets are burned in hand-fired furnaces by the preferred alternate hearth method, the amount of smoke produced is approximately the same as that produced by 23 percent low-volatile coal fired by the conical method preferred for low-volatile coal. (Author's abs.)

1942


A research program to solve the problem of burning bituminous coal smokelessly in nonmechanical heaters was undertaken at Battelle by Bituminous Coal Research, Inc., in cooperation with 29 manufacturers of solid-fuel-burning stoves, whose business had declined because of the swing toward oil- and gas-burning equipment tested.

The main objective of research was the reduction of smoke emission, the density of smoke being the principal criterion of the performance of the various pieces of equipment.

The heater, developed in the laboratory, showed promise of solving the problem, but the principle involved in the construction of the improved heater could not be disclosed at that time.

1943


The function of a furnace for power purposes is to mix the fuel with the air under high-temperature conditions and in the proper proportions, thereby liberating the heat therein and making it available so that the boiler can perform its function.

1947


The studies that led to the development of the Illinois smokeless furnace, begun in 1955, consisted of experiments with a downdraft conversion burner installed in a hand-fired furnace. An experimental furnace, designed specifically to facilitate the study of all the factors affecting the performance of a smokeless furnace, was constructed in the mechanical engineering laboratory in the summer of 1939. The first commercial model was completed in December 1942. It consists of an integral assembly of a number of parts, including a coking chamber, a coke-burning chamber, a baffle wall, 3 separate air orifices, and 2 forms of grates. In the coking chamber each charge of fresh coal is converted to coke, while that converted from the previous charge is burned in the coke-burning chamber in the back. The volatile matter released from the fresh coal mixes with the secondary air introduced through vertical air passages at the baffle wall. The mixture then passes over live coals in the coke-burning chamber, where it is ignited. The burning is completed in the combustion flues and the auxiliary combustion chamber above the flues. Provision is made for controlling the rate of gas release and the air supply to insure thorough mixture of gas with secondary air and the ignition of the gas-air mixture. In general, the present designs are well adapted to normal production practice, involving the fabrication of sheet metal. A study has not yet been made of the modifications necessary to adapt the smokeless principle to cast-iron furnaces or to boilers. Performance tests of the furnace were conducted in the laboratory to determine the burning characteristics of a wide variety of solid fuels.

In general, the density of the smoke resulting from the burning of high-volatile coal over a wide range of burning rates was comparable with that obtained in using an underfeed stoker and was well within the limits imposed by existing smoke ordinances. Data on the desirable proportions of the three sets of air orifices and on the operation of dampers placed over the orifices are presented. The use of a combined check damper and draft regulator, together with dampers used in connection with the orifices, is recommended. (APB)

1948


Gives details of experiments conducted in one of the commercial smokeless heaters developed at Battelle Memorial Institute for Bituminous Coal Research, Inc. Includes history, development, and general description of the heater; quotations from Bituminous Coal Research; manufacturer's descriptive and instructional
material; and "an introduction to fuel terminology and the significance of tests for coal." (APB)

**3433. BITUMINOUS COAL RESEARCH, Commercial-Type Smokeless Furnace in Field Trial Stage. Vol. 8, 1948, p. 4.**

The design of the B. C. R. smokeless warm-air furnace, which burns any kind of coal without producing smoke, is based on the fundamental principle of smoke abatement—to prevent smoke from being formed while the coal burns rather than attempt to burn smoke after it has been formed. In a field trial model now being tested in a house the ashes are removed from the fuel bed by a special type of grate that sifts out the ashes and retains the combustibles. A dump grate removes slate and other impurities that are too large to sift through the grate. To eliminate shoveling, ashes are removed from the furnace by a drawer-type ashpan that rolls rather than slides from the furnace. Under zero-weather conditions refueling was necessary every 12 hours, but it is expected that refinements in the field trial models are expected to produce a furnace that will requiring refueling only once a day in average weather. A record is being kept of variations in house temperature to determine the effectiveness of the furnace to demands for heat when operating on thermostat control. (APB)

**3433. ———. B. C. R. Develops Smokeless Boiler. Vol. 8, 1948, p. 5.**

In the B. C. R. smokeless low-pressure heating boiler developed in the laboratory and now in the stages of practical engineering design Bituminous Coal Research, Inc., has successfully applied to residential heating boilers the theory of smokeless burning of coal. The principles of this boiler permit conversion of a conventional cast-iron vertical-section boiler to the smokeless crossfeed magazine type. Changeover entails the use of different-type grates and firing door and the addition of one or more special boiler sections. Practical application to steel-heating boilers is also in progress. (APB)


The invention relates to a device for separating a furnace from a combustion space by means of a bridge formed of a plurality of contiguous sections, each provided with an outlet for the introduction of steam and air into the combustion space to consume any unburned gases; the steam, which is preferably superheated, is supplied to the various sections through a plurality of outlets in a communal steam pipe. (APB)


The question was asked whether all the ministers concerned would endeavor to evolve and enforce a policy by which existing inefficient domestic coal-burning appliances throughout the country would be replaced before a certain date by approved and scientific apparatus. The reply was that the ministers concerned recognized the importance of replacing inefficient domestic coal-burning appliances by efficient ones as soon as was practicable but that the question was a long-term one and depended on a number of factors, such as production capacity, capital-investment policy, and financial considerations. (APB)


Tests carried out on the new downdraft furnace fired with high-volatile bituminous coal are described. Smoke tests for different conditions of operation are shown. (APB)

**3437. HANSARD (HOUSE OF COMMONS). Domestic Heating Appliances. Vol. 446, 1948, p. 1892.**

The Minister of Fuel and Power stated that the output of improved solid fuel burning appliances is not yet high enough for him to prohibit the sale of appliances falling below approved standards, as recommended by the Fuel and Power Advisory Council. (APB)


A blast furnace in which cyclones for dust removal are fitted for the first time in France is briefly described and illustrated. The furnace is designed for a daily output of about 700 tons of pig iron, with a coke consumption of about 900 kg. per ton of iron. (FA)


A smoke eliminator, designed and developed at the Fuel Research Station, was displayed at the Engineering and Industrial Equipment Exhibition at the Royal Horticultural Hall, Westminster. Fitted to an ordinary boiler, it has been found to save at least 10 percent of the fuel consumed, at the same time eliminating much of the smoke that pollutes the atmosphere and wastes fuel. The smoke eliminator is a simple furnace door which regulates the flow of air over the fuel bed. By allowing the use of the maximum amount of combustible gas, the eliminator is making a great contribution to the fuel-saving campaign. Present fuel saving with these doors has been estimated at 20,000,000 tons a year. About 100,000 doors are being sold each year. (APB)


Describes the operation of the hot-air Lennox furnace, which is based on the downdraft coking principle. Volatiles are burned off in a refractory flue, the burning coke providing the ignition surface, while a perforated plate allows secondary air to enter just where it mixes with the volatile gases. (APB)


Work on smokeless heat equipment in progress at the University of Illinois since 1939 (see Bull. 370 of the University of Illinois) and at the Battelle Memorial Institute at Columbus is reviewed, and the new B. C. R. 2C heater is described. This model has a total fuel capacity of 70 pounds and requires refueling only once in 12 to 24 hours. Tests at Battelle have shown that this has a rating of 40,000 B. t. u. per hour; it operates satisfactorily both on induced and on natural draft. (APB)

**1949**

**3442. BITUMINOUS COAL RESEARCH, B. C. R. Develops Low-Cost Radiant-Type Smokeless Heater. Vol. 8, 1949, p. 8.**

Illustrates heater developed at Battelle Memorial Institute and tested there and in the laboratories of the Champion Coal Co. This heater has a maximum heat release of 25,000 B. t. u. per hour, as compared with 40,000 B. t. u. per hour for the first one developed. (APB)

**3443. ———. Smokeless Heaters for Bituminous Coal. Vol. 8, 1949.**

This manual for distributors and dealers on the sale, installation, operation, and service of residential coal-burning heaters describes principles of design and smokeless combustion for easier operation and decreased fuel costs and contains information on proper heater operation. (APB)
3444. COAL FURNACE. University of Illinois Foundation. British Patent 630,224, 1940.
This patent relates to a coal furnace designed for the smokeless combustion of high-volatile coal. (FA)

A low-cost, hand-fired smokeless furnace in which bituminous coal can be burned efficiently and smokelessly, a research project of the University of Illinois, is described. Results of tests of this new type of smokeless furnace in the research residence are discussed. Although it may be many years before the present types of hand-fired furnaces, stoves, boilers, and water heaters are replaced by smokeless heaters, very definite progress has been made toward that ultimate goal owing to the work that has been done by the University of Illinois and by Bituminous Coal Research at Battelle Memorial Institute in cooperation with several manufacturers of furnaces, stoves, and firebrick.

Reviews measures adopted by American utilities to deal with air pollution by smoke, fly ash, and cinders. Noteworthy is the installation of a "cyclone furnace" in which most of the ash is collected as a molten slag and relatively little dust leaves the furnace in flue gases. (APB)

Describes methods for eliminating smoke from batch-type brick-kilns or "air furnaces" in which cast-iron chunks are melted. (APB)

1950

In city smoke-abatement work approval of the dimensions of fuel-burning equipment is customarily required. This is to insure that, given reasonable attention, the equipment can be operated without smoke, having such features as ample furnace volume and air supply. To answer the many inquiries that come to the Bureau of Mines as to what dimensions are acceptable and standard, the requirements of a number of smoke-abatement ordinances have been tabulated.

Study of these tabulations shows that even after many years of fuel-burning practice and experience there is no common standard. Variations in the requirements for the same type of equipment under the same conditions of operation are great, causing considerable difference in installation costs. As overall costs are thus affected, the competitive positions of different types of fuel-burning equipment are also affected. Apparently, there is a lack of information as to proper dimensions that is commonly accepted as authoritative.

Smokeless burning of the cheapest soft coal at a big saving over ordinary hand firing is claimed for a new type of warm-air furnace developed at the University of Illinois and recently placed in production.

Work on the invention was begun in 1935, but production of the furnace was delayed by the war. The aim was to achieve smokeless burning of the cheapest coal in home-heating plants, which smoke authorities blame for the bulk of city air pollution.

Any bituminous coal can be burned without smoke if hurbers have the right equipment. This fact recently was made clear to thousands of people, including city officials, in Knoxville and Kingsport, Tenn., when two coal-burning heaters—an old-fashioned burner and a newly developed smokeless burner—were fired side by side in the public squares of the two cities. Both were charged with the same high-volatile coal. Out of the stack of the old-style burner came a cloud of smoke. The stack above the new-type burner remained clear.
The smokeless heater used in the demonstration is the result of several years' work by B. C. R. and leading coal-stove manufacturers. It is a magazine-type burner with automatic feed and large capacity. The demonstration was arranged as part of National Air Pollution and Smoke Abatement Week, October 22-28.

Smokeless residential coal-burning heaters, developed by Bituminous Coal Research and the Stove Manufacturers Research Group, are now being manufactured. Under the name of Martin smokeless heater, 250 are now being distributed for trial in cities in 14 States. A public demonstration of the heaters was given at Winston-Salem, N. C., November 29 and 30, 1949. (IH1)

1951

Presents results of tests run to obtain the efficiency and the unaccounted-for losses, over a wide range of burning rates, of two deep-flue-heat, a smokeless heater, and a conventional surface-fired heater while burning high-volatile bituminous coal. All heaters were commercial models.
A description of a specially constructed calorimeter room in which the tests were run is included; this room permits an accurate determination to be made of the heat losses in the form of smoke and unburned tars and gases, which in conventional tests in the past have been termed the unaccounted-for losses. Data on the useful heat transmitted to a room from a typical flue-pipe installation are also presented; curves for the four heaters tested show overall house-heating efficiency when the useful heat from the flue pipe plus that from the chimney are taken into account. (Authors' abs.)

1953

Clain 1: A soot-removal composition consisting of an admixture of a copper chelate compound capable of volatilizing at normal furnace operating temperatures and a volatile chlorohydrocarbon in a proportion to provide a total chlorine to copper atomic ratio of at least 2 to 1. (APB)

SMOKELESS ZONES

1947

Systematic observations made during 1937-39 of atmospheric pollution at Leicester indicate that smokeless zones are in effect zones that do not produce smoke, since it was found that the smokeiest district in Leicester was the center and that the maximum effect of wind was to move the point of maximum smoke con-
centration half a mile downwind. A well-defined relationship has been found to exist between the optical density of the coal and the quantity and composition of the suspended matter and the combustible gasous constituents of the flue gas. (APB)

1948


Five post-war housing estates, in which the houses are equipped and built to be used with coal capable of burning smokeless fuel, have been selected for the opening stage of a new anti-smoke campaign, made possible by powers conferred in the new Salford Corporation Act for the establishment of smokeless zones. When the zones are established it will be illegal to supply coal to any premises in the area, and the tenants will have to use gas, electricity, coke or other smokeless fuel for all purposes. In due course the areas will be linked up by other smokeless zones until the whole of West Salford is smokeless. (FA)

1949


The Rochdale Corporation Act, 1948, gave the corporation power to prohibit the emission of smoke from the central area of the borough, and, by extension, any other area or areas. The provisions will be brought into force with respect to the central area by 1953. This area covers 674 acres and contains 322 different premises, mainly nonresidential. Probably new housing will be built as a "smokeless zone." This will be fitted with appliances suitable for smokeless fuel; any household which will be long be automatically declared to be smokeless zones, and extensions may be made the neighborhood type which will now be fitted with appliances suitable for smokeless fuels will be made. (FA)

1950


The coal industry once prospered on waste, but that page in history belongs to the past. How many million tons of smoke, soot, tarry matter, and unburned gases were discharged into the atmosphere in this period no one will ever know. What is everybody's business today is to eliminate as much waste as possible, for coal is no longer plentiful, and, moreover, it is expensive. The old adage that "where there is smoke there is money"—never very sound logic—has no substance whatever today; smoke is now recognized to be a crime of civilization. This matter was taken up recently before the Smoke Abatement Society. The subject chiefly centered on "smokeless zones," a conception which has received a great deal of publicity in recent years and has found favor with a number of municipal authorities. While making it quite clear that smoke abatement is supported wholeheartedly and that all possible progress should be made, the society sounded a note of warning in the fact that there were practical limits to what could be done in instituting zones of this kind. Modern large-scale combustion equipment, when properly handled, gives little scope and certainly no excuse for discharging smoke into the atmosphere, but the small-scale domestic appliance is in a different position altogether. The total elimination of domestic smoke could be achieved in only three ways: by extending the use of electricity, by using gas, or by burning one of the various forms of solid smokeless fuels. The domestic cooking and heating load for the whole country could not, however, be met by these means, as the question of supplies, peaks, and cost must necessarily be considered.

In point of fact, only 6 million tons of a total domestic demand for 35 million tons of solid fuel per annum could be met by the smokeless varieties, and there is little prospect of substantial additional supplies being available for some years to come. Whatever the increase there may be in the supply of anthracite and carbonized fuels it will not go far to eliminate the 29 million tons of bituminous coal used in the home every year; even more than this quantity would doubtless be used if supplies were freer and cheaper.

The ultimate solution to the domestic smoke problem lies in the progressive development of appliances that will burn bituminous coal with less and less smoke. This aim, however, is not likely to be achieved for a number of years, and in the meantime there is danger that the conception of smokeless zones, if their establishment is pressed too hard, would be discredited. If the present supplies of smokeless fuels are to be used to the best advantage, they should be confined as much as possible to new towns in which the houses could be equipped with suitable appliances at the time of construction. In this way the standard of the smokeless zone would be fully maintained as a desideratum to be achieved on an ever-extending scale as the problem of smokeless combustion becomes progressively solved. In the meantime, in other areas the correct procedure would be to accept a less stringent standard than the absolute smokelessness required under the present corporation acts: a true progressive program in which better appliances would be progressively installed. This course would result in ever-increasing smoke reduction over the country as a whole and would form a much more practicable contribution to smoke abatement than the piecemeal introduction of isolated smokeless zones, with all their attendant difficulties of fuel supply. No suggestion was made as to how, in practice, this progressive development might be promoted.

1951


Transformation is one of the three basic procedures in the control of atmospheric pollutants that do not require collection of the pollutant from the effluent.

In this discussion "transformation" refers to those atmospheric control procedures that depend on transformation of a harmful or objectionable substance into one that is not harmful or objectionable.

An excellent example is the transformation of carbon monoxide to carbon dioxide in contact with a hopcalite catalyst in a universal gas mask.

Other examples are smoke abatement through complete combustion of the fuel and combustion of hydrogen sulfide and carbon disulfide to sulfur dioxide.

Although the transformation of objectionable substances, without the necessity of collection, has been successfully applied to the control of atmospheric pollutants, the method is limited, in general, to substances that are readily oxidized. The main disadvantage of the method is cost of fuel. It is not anticipated that transformation will have wide application, but for certain problems it may be the simplest solution.

1951


Dismal prospects, smoke abatement and fuel economy go hand in hand. The Ministry of Fuel and Power has issued a stoker's manual and given courses for the general education and the better equipment of stokers for carrying out their job. The Public Health Act 1936, embodies the provisions of previous acts from the time of the introduction of railways in the 1840's. Local authorities take their job very seriously. One of the problems is that under the Public Health Act, 1936, unless it is black smoke that is emitted, the offender can clear himself by proving that he has used the best practical means to eliminate the nuisance. The Health
Ministry is always available to local authorities when they are in difficulty with any special problem. Smokeless zones depend largely upon the planning of the area. If, as one finds in Sheffield, domestic properties and factories are intermixed it is impossible to bring those areas into smokeless zones. Where factories are sparsely spread in an area and the industries are of a type that a change of power is a practicable proposition, negotiations are undertaken with the people concerned. The question is whether or not they can change to smokeless solid fuel, gas, or electricity. Industry generally is very cooperative, if not from the point of view of smoke abatement then because industrialists believe that abatement is a paying proposition. However, industrialists can get all the machinery they want for the changeover. It is claimed by some people, particularly some industrialists, that pollution by domestic users of fuel is greater than that by industry. As far as new housing estates are concerned, there has been cooperation between the Health Ministry and the Ministry of Fuel and Power, and a group of solid-fuel appliances has been approved.

1892


This process consists in mixing the smoke as it leaves the flue with a small quantity of steam, generated in a boiler forming part of the kitchen range. The mixed steam and smoke pass into an open chamber, the top part of which is provided with a number of pipes, placed in the direction of the prevailing wind, through which the air passes and helps to cool the gases. At the extreme top of this chamber, just before passing into the atmosphere, the gases are met by a very fine shower of water issuing from minute holes in a pipe. The result of this treatment is a very thorough washing of the smoke and almost complete removal of all solid matters (soot and dust) and a large proportion of the sulphuric acid always present in coal smoke. The removal of the soot and dust is so perfect that a piece of wet cotton held in the issuing gases remains perfectly white even after long exposure. The amount of steam required is small and may be neglected in an estimate of the cost of working the process, as it is generated by means of heat that would not otherwise be available for any useful purpose. The only item of cost to consider is that of water. The amount used in the apparatus at Sloane Gardens was found to be about 10 gallons per hour; this includes the condensed water from the steam.

This apparatus treats the smoke from a large kitchen range burning about 20 pounds of coal per hour, but it can handle the smoke from several such fires. It is important to note that the draft is not sensibly impeded by the apparatus, any slight retarding of the flow of the gases being more than compensated by the action of the jet steam.

The results of a number of experiments with the apparatus at atmospheric temperatures ranging from 92° F. (33.3° C.) in the shade (part of the time the apparatus was exposed to direct sunshine) to 50° F. (10° C.) showed that almost all of the soot was removed and a large proportion of the sulphurous acid.

The apparatus is exceedingly simple to operate, being, in fact, almost automatic.


An automatic smoke recorder which exploits a moving strip of paper to the furnace gases is described.

1896


A map of the territory 60 km. east and west and 50 km. north and south of a part of Upper Silesia is interesting in that it shows Reuss's results in hundreds of a percent of H₂SO₄ for the vegetation of all parts. The determinations range from 0.2 to 1 percent in regions where there are a few industrial works (between Köbler and Mezeritz) to 80 percent in the vicinity of the most densely occupied industrial district (between Myslowitz and Kattowitz).

At a distance of 200 meters (656 feet) the advantage of the high stack ceases to be apparent. In damp, still, heavy air the smoke with its SO₂, which is heavier than air, falls rapidly to the ground. When the wind blows continually the smoke may be observed escaping from the high stack, gradually sinking and holding together.
for considerable distances, so that it does not suffer any unusual dilution. The smoke poured out from chimneys of different heights at first can be seen as separate masses, but at 100 to 1,000 meters (depending upon the differences in height) the different masses behave as if they exerted an attraction for each other and soon mingle into a thick cloud, which pursues its further course as a single mass. From these facts the difference in height of 60 meters (197 feet) does not produce a measurable difference in the degree of injury.

The amount of SO₂ that reaches the vegetation will depend (1) on the amount of acid that escapes from the chimneys, (2) on the distance of the latter from the vegetation, and (3) on the direction of the wind. The injury is increased by dampness and lessened by dryness.

The vegetation can stand a certain amount of acid gases without injury; beyond this amount it suffers.

1900


Reviews work of chimney observation and recommends suitable forms of boilers. (MIR—Bib.)

1901


Records observations made by committee appointed to test exhaust chimney cowls and terminals. Distribution of smoke issuing therefrom is shown by numerous sketches. (MIR—Bib.)

1906


This is a practical and comprehensive work on combustion as related to the efforts being made everywhere to abate the smoke nuisance. The main topics considered are heat and combustion, combustion and the boiler furnace, combustion and the steam boiler, the chimney evil, smokeless furnaces in general, mechanical stokers, and hand-fired furnaces.

The smoke evil is referred to as the greatest "nuisance in the world." Figures are available to prove this broad statement. Its widespread prevalence, the millions that come under its influence, and the hygiene, as well as economic considerations involved, make it rank as the chief of all nuisances.

"Chimney evil" is suggested as a more appropriate term because the word "smoke" does not convey the character of the evil factors involved.

Methods of determining the efficiency of the various types of furnaces are discussed. A smoke-gas analysis is stated to be the proper test for any device claiming to improve combustion. Such analysis not only determines the extent of the combustion but the percentage of surplus air carried with the chimney gases. If combustion is at the maximum and surplus air at the minimum, the highest efficiency possible is attained.

1909


To all lead smelters the fume question is of prime importance. Escaping fume means direct expense by loss of metal and indirect expense by possible payments of compensation to surrounding landowners. More especially is this true in Europe, where in recent years the strong competition for ores has reduced the returning charges to a point where the margin of possible profit is so small that it disappears altogether for those works that cannot recover nearly 100 percent of the metal values contained in the ore smelted and where the factory inspector is becoming more and more exacting each year. These causes have led to much work being done late in improving old methods of catching fume and in developing new ones.

Most of the new methods consist in passing the furnace gases through a more or less complicated system of water sprayers; the fundamental theory is that the fume will be caught by the particles of water and carried down to be recovered in suitable settling tanks, filters, etc.

The spraying process used at the Silberhütte smeltery is described. It is capable of considerable development and promises good results.

1910


Dust in smelter gases consists of particles of the ore charge, ash, and slag of the ore as well as of dust carried over from the furnace. This dust is primarily a mixture of the sulfates of iron, copper, zinc, and carbon, and other bodies, the settlement of which is largely influenced by the cooling of the carrying gases. The best method of collecting the dust is by reduction of velocity before air is introduced into the flue or stack system. The total recovery of fume is difficult. It attaches itself to a surface. Whether fume collection by surface adhesion is a more practical method than filtration through bags has not been decided.

1911


Upper part of chimney is so perforated that smoke does not issue from top in compact stream but in dilated condition from numerous horizontal channels. (MIR—Bib.)

1916


By properly located apertures near top of chimney, air is gradually introduced, and smoke and gases are diluted. (MIR—Bib.)

1916


The term "draft" is defined, and two types—"suction" and "forced" draft—are discussed. Modern boiler practice indicates that for the larger and more important plants at least something more than ordinary chimney draft is needed. Every means should be used to prevent air from entering the gas passages other than through the fuel bed, and loss of draft due to restricted, improperly designed and obstructed flues should be reduced to a minimum. The boiler and furnace will then be in condition to give maximum efficiency.

1929


The function of a chimney is (1) to create a draft so as to furnish the necessary amount of oxygen for complete combustion of the fuel and (2) to carry the products of combustion above the living zone. The common causes of chimney troubles are enumerated, and specifications for chimney construction are presented.
1931


This article is for the practical use of plant designers and operators. Rational formulas are presented for chimney proportions, including cost as well as all physical factors that affect the problem. The charts and table permit rapid determination of the most economical size of natural-draft chimneys for typical atmospheric and temperature conditions. The basic formulas presented are applicable to any conditions. The purpose is to develop a system that permits determination of the most economical size of chimney and at the same time takes into consideration all of the various operating factors that affect the size in one way or another.

1933


Much has been written in recent years about the economical proportioning of chimneys and methods of design; specialists on the subject during the past 20 years have given much attention to its mathematical aspects and too little to the results of numerous experiments. The formulas developed apparently represent the best analysis of chimney proportioning extant, as they take cognizance of the factors presented by all known competent investigators. Further study and experimentation are required to substantiate the theory presented.

1936


The fact is stressed that space-concentration distribution governs the general environment of pollution, to which buildings and people are subjected when it is not raining; the effects from acids are dependent on humidity, while those from dust are largely independent of humidity.

A theory concerning vertical diffusion is presented. Attention is called to the widespread misconceptions existing in the past concerning: (1) Chimney height. Any considerable height has no practical effect. (2) Concentration at moment of emission. This really is of very little importance in practice, the most important factor in the problem of atmospheric pollution being the mass rate of emission of the objectionable constituents for any and every particular case.

1937


Chimney loss of heat is discussed, and a device to record this loss is explained.


Some 35 million tons of coal is consumed annually for household purposes in Great Britain and some 130 million tons industrially. From the smoke and grit produced arises great atmospheric pollution, with its attendant evils. While the open fireplace remains an unsolved problem in the control of smoke production, excessive emission of tarry vapors or soot from industrial furnaces is inexcusable, yet the escape of dust is difficult to control. Fuel often contains 10 percent of ash; where powdered coal is fired most of the ash particles are less than 10 microns in diameter. The use of cleaned coal reduces the amount of ash, and dirty coal is not necessarily cheap coal; but even cleaned coal contains 3 to 5 percent of ash. The ash may be clinkered in the furnace and run off at intervals as molten slag, or extraction plants may be used to remove the dust from the flue gases before they escape. These plants may be of the dry or wet type. The dry types allow the dust to fall by gravity in large chambers; employ centrifugal force, as in cyclone separators; or employ electrostatic means to deposit it. Wet methods are used especially for sulfur removal; here spray chambers are used. In one large power station flue gases at the rate of 1/2 million c. f. m. are scrubbed in a system through which they take 30 seconds to pass, and 20 tons of water is pumped through sprays for every ton of coal burned. Other methods are constantly being tried; adequate means are now available for preventing excessive emission of dust and grit into the atmosphere. At the same time increased public interest is demanding that the nuisance be abated. (JH)

1938


What is supposed to be the tallest chimney in the world, which serves the Selby plant of the American Smelting & Refining Co., is described.

1940


Some fundamental work done on the control of atmospheric pollution by power plants is described in a preliminary report. A model power station and surrounding buildings were built and placed in a wind tunnel, where the effects of wind velocity, stack-gas velocity, and stack-gas temperature could be observed. Further details of this work will be published soon. (JIHT)

1942


The structural characteristics and requirements of chimneys for various purposes are discussed in detail. Chimneys have been in general use for less than a hundred years. They were developed along with modern industry and clearly indicate the industrial wealth of a community. Referred to as smokestacks, smoky chimneys, and smoke producers, chimneys are often blamed for smoke conditions to which they may have contributed little or nothing around the smoke or gas plant. If the chimney is large enough for the maximum operating conditions of the plant, it will not cause or assist in the production of smoke. Tables are given showing the economical sizes for natural-draft chimneys, based on the factors HD (product of height and diameter).

1947


To prevent pollution of a residential area by a new generating station, an investigation of the performance of various stack and building factors was made in a wind tunnel. The problem was resolved into three distinct phases: (1) To establish the wind and weather conditions that would produce the most serious smoke annoyance; (2) to determine the effect of adding units to the plant; and (3) to investigate all possible means for improving dissipation of the gases.

When compared with an actual installation, a model of another plant was found to give good agreement. Since the maximum stack height in this investigation was limited by an adjoining airport, a compromise had to be reached. The model tests indicated that a stack height of 157 feet above ground level or 1.5 times the
height of the boiler-room monitor would reduce smoke nuisance to reasonable limits in a 20-m. p. h. wind.

A stack velocity of 60 f. p. s. was found desirable. None of the special stack designs or shields proved satisfactory. The influence of surrounding structures greatly changes the turbulence pattern. (JHIT) 1944


High stacks, coupled with high temperatures, have largely solved the sulfur dioxide problem at many smelters. Moreover, they have vastly improved operating conditions by added draft.

The curves shown tend to corroborate the Rosanquet and Pearson formula, which shows that gas concentration varies inversely as the square of stack height. (JHIT)


Preliminary plans of the New York City Tunnel Authority for the Brooklyn-Battery vehicular tunnel included a ventilation building adjacent to a group of large office buildings. To obtain data on the conditions obtaining in the immediate vicinity of the ventilation stack, an open-circuit, open-jet wind tunnel was constructed, and tests were made on two models, approximately 1/200 and 1/400 scale, representing the proposed ventilation building and adjacent office buildings. The actual experimental work was carried out in three steps: (1) Visual study of fumes discharged from the stack, (2) preliminary series of tests of the rate of dilution of carbon monoxide discharged from the stack, and (3) final series of tests of the rate of dilution of hydrochloric acid gas discharged from the stack. The results show that general form of the stack-discharge stream is that of an expanding jet bent by the wind. The form, position in space, and contaminant content of the stream in the absence of extraneous turbulence can be expressed in terms of distance, measured in stack dimensions, for any ratio of wind velocity to stack velocity. Maximum relative concentrations at adjacent buildings were comparable to the maximums in undisturbed space within the building-generated turbulence was the minimum, but in general they were but 1/2 to 1/3 of these values. No scale effect was observed. (FA)


A study was made to determine whether a stack could be properly designed to discharge 1,000,000 c. f. m. of exhaust air from the Brooklyn-Battery vehicular tunnel without causing adverse effects to occupants of adjoining buildings, as this gas contains a maximum of about 15 p. m. of carbon monoxide as well as other contaminants.

Fundamentally, the problem was that of discharge of a turbulent jet into a cross wind for which no theory had been developed. The attack on the problem was made by models placed in front of an open-circuit, low-velocity wind tunnel designed especially for this problem. Studies were made of fume discharge from the stack, rate of dilution of CO, and rate of dilution of HCl discharged from the stack. The theory of turbulent mixing of the jet in the immediate vicinity of the discharge is in part, and the difficulties involved in applying them to this problem are discussed. The results obtained from the model study show that the form, position, and relative containment content of the discharged air stream can be closely correlated with two major parameters: The ratio of wind velocity to stack velocity and the distance from the point of discharge expressed in stack dimensions. Simple mathematical equations are developed involving these parameters and the other important variables. From these formulas a chart was prepared for rapid computation. This chart holds only for turbulent-flow discharge from the stack.

This is an excellent study and will be of considerable value to investigators of atmospheric pollution. (JHIT) 1946


Describes the general characteristics of mixing and the amount of dilution that waste stack gases would undergo when discharged into the atmosphere. Dilution was assumed to depend upon the meteorological conditions. For the experimental work a 16-inch stack 200 feet high was erected through which, by means of blowers, the whole discharge of an Army M-1 "smoke" (oil-fog) generator was ejected into the air. The stack was provided with 1 1/4-inch outlets at each 50-foot interval (up to 150 feet) through which came enough smoke to act as tracer for air flow at the various intervals. These jet pipes extended outward from the stack; from each jet and at 200 feet a shielded thermocouple was suspended and connected to a precision potentiometer in the nearby office building. Recording anemometers were placed at 16 and 60 feet and a recording anemometer and wind vane at 200 feet. This instrument arrangement provided data on the lapse rate, the wind velocity, the change of wind velocity, and the wind direction of the stack top.

The smoke generator produced a dense white cloud of condensed oil particles about 0.3 micron in diameter. The droplets were very stable. The terminal velocity of the falling droplets was about 0.2 inch per hour. After the oil fog passed through the blowers and 10 feet of the stack, its temperature was near 135° F. No observations were made of its temperature difference between the atmosphere and the oil fog; essentially, the oil fog may be considered as "cold" smoke with a negligible lift owing to its temperature.

Each day, or more usually, the "densitometer" was calibrated by drawing from the stack a known volume of oil fog, mixing it with a known volume of air, and then forcing this mixture through the instrument. Several different concentrations of mixture would be used each time the instrument was calibrated. The instrument would measure concentrations as low as 1/50,000 of that in the stack.

The oil fog followed to a high degree directly, without appreciable lag, any and all the air movements in the area occupied by the oil fog; its presence did not materially affect the air movement in any direction; and the dilution of the oil fog represented within reasonable limits of accuracy the dilution of gaseous or minute solid particles emitted from a stack under similar meteorological conditions.


Smoke-elimination progress is reported for 1945 in Pittsburgh. The inspections and alterations in equipment made are summarized and their implications discussed. (FA)


A preliminary report of an investigation, conducted in a wind tunnel on model ships, to determine what principles must be followed in the design of stacks to insure that the products of combustion stay clear of the ship once they have been discharged. (APB)
CONTROL OF AIR POLLUTION


The Minister of Fuel and Power was asked what steps the Government proposed to take to reduce the waste due to loss of heat in smoking chimneys, calculated to be equal to about 10 million tons of coal each year. The reply was that various steps had already been taken to deal with this problem. The fuel engineers of the Ministry of Fuel and Power visits industrial undertakings to advise on efficient boiler-house practice to reduce heat losses caused by incomplete combustion of fuel. They give practical demonstrations at works, set up courses of instruction, and send their data and give active encouragement in the development of more efficient fuel-burning equipment. As regards domestic consumption, assistance is given to local authorities in the selection of improved appliances, designed to increase the efficiency with which fuel is consumed. Plans for district heating schemes are being developed. Further progress must depend largely on increased production of more efficient heating appliances and a larger output and use of smokeless fuel. (FA)


The necessity for an engineering approach to the solution of smoke problems is stressed. (FA)


Experimental data on diffusion have been accumulated for many years at the Chemical Defence Experimental Station, Porton, Wiltshire. The mathematical theories developed at Porton are applied to the problem of the distribution of smoke and gases from sources such as found in the industrial surface of the Porton data and used in obtaining numerical values. The maximum concentration of smoke at ground level due to a chimney is found at a point whose distance downwind from the chimney base increases somewhat more rapidly than the height of the chimney. The chimney concentration itself varies inversely as the square of the height of the chimney. The results apply to average conditions, defined as those associated with small vertical gradients of temperature. When the lapse rates are large (that is on warm, clear days in summer), the turbulence of the air is much increased, and the cloud is diffused more rapidly in all directions. This means that, in general, smoke will be found nearer the chimney base but at a lower concentration. When a surface inversion forms (that is, on a clear night), the smoke will tend to drift away from the chimney in a much more compact cloud, so that the point of maximum concentration at ground level will be displaced farther downwind, but concentrations will everywhere be higher and will fall off more slowly with distance. Trouble from industrial atmospheric pollution can be reduced primarily in two ways: (1) By high stacks which are essential wherenoxious fumes are emitted, and (2) by some method of meteorological control. (FA)


Gives results of tests conducted at the National Bureau of Standards to determine the performance of 14 chimneys of various types of construction under conditions simulating those of domestic chimneys. Tests were made at an inlet temperature of 200°, 500°, and 1,000° F. and at gas-flow rates of 20, 40, and 70 c. f. m., corresponding to a fuel burning rate of ½, 1, and 1½ gallons of fuel oil per hour, respectively. Brick-chimney performance was compared with others in which such materials as shale tile, cinder concrete blocks, and fire clay or metal liners were used. (APB)


Regardless of the causes, in recent years there have been growing demands on industry for relief from airborne pollutants. Although the fact must be faced that the atmosphere of industrial communities cannot be as clean as that of the countryside, on the other hand, industry has an obligation to do everything reasonable to minimize atmospheric pollution.

The need for specific information about the magnitude of stack emission by industry and the effect on the community is stressed. Some of the topics discussed are ground-level concentration in relation to the stack, reasonable pollution level, controlled atmosphere tests, evaluation of tests, control, and public information. (FA)


Stakes are presented as some corrosion trouble at a power station and the resulting investigations. Steel stacks in position for 11 years were examined, and the ½-inch mild-steel plates had rusted away evenly on the inner surface to 1/16 inch. The plates were analyzed and the results are given. (FA)


Four different types of residential chimneys were tested at the Battelle Memorial Institute for performance under laboratory conditions. (APB)


The work of the Coal Producers' Committee for Smoke Abatement is reviewed. It is stressed that abatement of smoke will not completely clear the atmosphere over any industrial city, as a good part of the pollution comes from industrial fumes and exhausts, waste disposal, building construction and destruction, exposed soil surfaces, and just plain dust. The findings of the Chicago Association of Commerce from a comprehensive research to correlate other factors with dustfall collections are quoted. (FA)

1949


The following subjects are considered: Physical factors involved in the design of chimneys, considerations of efficiency, fire pickup in solid-fuel-burning devices, requirements of height and cross sectional area of chimneys, fire hazards, and the smoke problem. (IHD)


Describes work being done at Brookhaven National Laboratory and discusses the difficult problems involved. Analyzes effects of stack-design and meteorological parameters. (FA)


Abstract of the original paper. (FA)
AIR POLLUTION—A BIBLIOGRAPHY


Experimental field work on dilution of stack gases at the Hanford Works was conducted by forcing a continuous stream of oil fog up a stack 16 inches (40.5 cm.) in diameter and 200 feet (61 meters) high and measuring photoelectrically the comparative concentration of smoke (considered as 1) of the oil fog and mixed air at known distances from the stack under known conditions of vertical temperature gradients and wind speed. Under thermally unstable conditions, with low wind speed, stack gases will reach the ground close to the stack and may be diluted with as little as 300 volumes of air. With higher wind speed, the distance becomes greater and the dilution much greater. With neutral stability (mechanically mixed) stack gases will reach the surface some 8 to 10 stack heights downstream. This condition prevails when the wind exceeds 20 miles (32 km.) per hour. When the air is stable, stack gases remain embedded in a thin horizontal layer which widens, thickens, and also moves with the wind. This effect is shown with as little as 400 volumes of air in more than 0.2 mile (0.8 km.) has been measured. (AIHOM)


The British Electricity Authority has advised research work by the National Physical Laboratory into the problems arising from the emission of smoke and fumes from the Neepsend power station, Sheffield. One suggestion is that chimneys about 400 feet high might carry the emissions over the surrounding hills, but to build one chimney of this height would probably cost $80,000 to $70,000. A meeting of the Sheffield Health Committee it was decided to ask the B. E. A. to end the nuisance caused by sulfur fumes and grit from Neepsend and Blackburn Meadows power stations; it was reported that the average monthly deposits of solid matter in the Winceheath area last year was 4 times as much as in 1932, while the sulfur content had increased 50 percent. Under certain conditions the fumes were so potent that people in the district were compelled to protect their eyes. (APB)


This report is a review of the work done during 1949 by the Bureau of Smoke Prevention in connection with all of the stationary stacks within the city limits of Pueblo.

It is estimated that there is some 65 percent less dirt now in the Pittsburgh atmosphere than there was 4 or 5 years ago. This conclusion is based on common observations, letters from housekeepers, absence of any smoked over 2 years, readings of the United States Weather Bureau which shows 50 percent improvement in the last few years, and railroad records showing more than 65 percent improvement in smoke conditions due to the use of many diesel locomotives. Also, average conditions are estimated to show 75 percent better conditions. Dustfall caught in cans placed on top of buildings shows some 30 percent less dirt, (weight), and better combustion in the city than in the surrounding communities.


A historical review of the struggle to prevent pollution of the air by smelter fumes is presented. Certain smelters were enjoined from operation until they could do so without injury to the farmers' crops. The accomplishment of the efficient means of smoke treatment today stands as a monument to the zeal and resourcefulness of the men who pioneered in the field of smoke control that smelters and farmers might occupy adjoining lands without strife.

Methods of control and their effectiveness are discussed. (20 refs. cited)


A general review of the power-station chimney nuisance criticizes the economic efficiency of gas-washing plant and suggests that efficient combustion and grit-catch engine form the solution of the problem. (APB)


Some of the accomplishments of the electric light and power industry in the reduction of atmospheric pollution are presented. This industry has done more than any other and probably as much as all other industries combined to reduce smoke and cinder emission from stacks. The methods used and the results achieved are discussed in detail.


The development of atomic energy for peacetime industrial uses will make "stack meteorology" an important science of the future. It is predicted that large atomic-energy plants will release into the atmosphere materials that are either unusually toxic or measurably radioactive.

"Stack meteorology" is defined as "the entire problem of air pollution from stacks of chimneys as the meteorologist sees it."

The fogging of photographic plates occurred a thousand miles from the first atomic-bomb explosion in New Mexico. Dust from the great Krakatoa volcano has traveled around the world. Industrial smoke and fumes are likewise carried greater distances than is generally realized.

Aviators have seen smoke from large cities adequate to dirty their windshields and to decrease visibility up to 300 miles away from the smoke source.


The theoretical equations of Bosanquet and Pearson and Sutton for the dispersion of smoke from factory chimneys have been solved in terms of the conventional units of the smelting industry for the elimination of sulfur dioxide from four smelters. A large mass of field data for sulfur dioxide in the atmosphere, obtained by means of automatic recorders, have been evaluated in the form of Cg to M ratios, where C is the field concentration, M is the mass emission of sulfur from the plant, and α is the wind velocity. The data for tall stacks at Selby, Calif., Tacoma, Wash., Garfield, Utah, and El Paso, Tex., agree well with the theoretical equations, when values of the diffusion coefficients of 0.05 to 0.07 are used and the exponent of distance s in Sutton's equation is 2(s = 0). A somewhat smaller exponent may be needed to satisfy the data for the short stacks at Selby and El Paso. The theoretical curves and confirming data illustrate forcefully the beneficial effects of using tall stacks in dispersing air contaminants from factories. Maximum ground concentration varies inversely with square of stack height. This results in lower peak and lower average concentrations from the tall stack and higher percentages of time when air is free of contamination. High temperature of smoke elimination increases effective stack
The theoretical work is described on a project on smoke diffusion by the Research Division of the College of Engineering of New York University and sponsored by the Consolidated Edison Co., New York. The experimental work was done with the Meteorology Group of the Brookhaven National Laboratory.

An hypothesis of the inversion case is presented, and the extent to which the theoretical results are borne out by the observations available is shown. In fact, if measurements of gas concentration are taken within a visible smoke plume at a fixed point downwind from an elevated stack, the average concentration is highest when strong temperature inversions exist. The stable case is not only of theoretical interest but also is of practical importance in those instances where tall structures downwind from the smoke source reach the level of the smoke plume.

The diffusion of stack gases during inversions is considered to be a two-phase problem. In the first phase the axis of the plume turns from the vertical to the horizontal. In the second phase the axis of the plume is horizontal; here horizontal diffusion exceeds vertical diffusion. The second phase alone is treated.

Abatement of pollution from metallurgical furnace stacks has received considerable attention during recent years. It has been estimated that the steel industry consumes over 1 billion gallons of fuel oil, several hundred billion cubic feet of natural gas, and over 100 million tons of coal each year.

Sections are discussed briefly of the smoke-control ordinance of Allegheny County, Pa., pertaining to steel mills and the progress that has been made in specific operations, such as removal of dust from blast furnace gas; improved furnace operational techniques to prevent the charge from slipping, which would otherwise increase atmospheric pollution; and collection of dust and fume from ferromanganese furnaces; studies on dust and fume loadings in open-hearth stack gases and methods for removal; research program for dust removal from smelter converters; and further studies in connection with smoke from coke ovens.

Heating and reheating furnaces and sintering plants does not normally contribute significantly toward atmospheric pollution.

The complexity of the problem involved and the amount of research needed to reduce atmospheric pollution from the steel mills is emphasized. (PHEA)

Several methods of stack-gas cleaning applying to the removal of particulate matter from stack effluents are reviewed. Particle conditioning through spontaneous induction or controlled addition facilitates final collection. The operating principles of inertial separators, fiber filters, wet scrubbers, and electrostatic precipitators are discussed. Specific limitations and applications are given for each collector type. (IIOM)

Some of the aspects of stack disposal of chemical waste are site selection, site layout, design of disposal facilities, city planning, research, and legal aspects.

An attempt has been made to show how dispersion characteristics of stack effluents vary. The degrees to which concentrations varies with time and distance from the point of release are shown. The stack effluents are not always present at a point even when the point is directly downwind from the source of contamination. Data are shown to demonstrate that stack disposal can be adequate in spite of the poor dispersion conditions that are found. The characteristics of dispersion have been discussed in light of the effects on phases of the problem, such as site selection, planning, legal aspects, and research in the medical field. It is admitted that exceptions may be taken to some of the concepts. The methods are offered to benefit those in industry at present grappling with the problem and who force must adopt measures now to solve their present problems. As it becomes available, additional information will be extremely beneficial, but the lack of undiscovered information should not prevent industry from taking a practical approach to treating the complexities involved in stack disposal as a means to eliminate or minimize air pollution. (Author's summary)

Control of atmospheric pollution by adequate dilution means mixing nonnormal or foreign components of the air with enough air to render their presence unobjectionable. As sulfur dioxide is such a constant product of combustion of all sulfur-bearing fuels and is, therefore, a universal air pollutant, it forms the principal basis of discussion in this paper.

Results of investigations of methods of controlling smelter effluents and fumigation experiments using sulfur dioxide in various concentrations revealed that stack height and temperature of the exit gases make a difference in the degree of dilution of the gas; that each crop differed widely in susceptibility to sulfur dioxide injury with variation in soil moisture, humidity, and light intensity; and that high concentrations quickly injured plants but as concentration decreased more time was required to produce injury until finally a concentration was reached that would not injure the most sensitive no matter how long it lasted. (16 refs, cited)

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In an analysis which may be applied to the problem of atmospheric pollution, the United States Weather Bureau has figured out height to which an atomic cloud will rise. It is maintained that the cloud from the first bomb explosion in New Mexico rose to 29,900 feet.

1951


Requirements for stack gas dust-loading tests as conducted by a smoke-regulation department are outlined.

The method used in Columbus to attempt to meet these requirements is discussed briefly.


The object of the committee in this connection was to assemble information from the literature and from personal experience on procedures that have been used.

The literature was reviewed, and a questionnaire was sent to about 100 individuals and organizations, who were believed to have an interest in stack sampling, to find out what it is doing or how they thought it should be done.

Stack sampling is a very important tool in air-pollution control. The concentrations and emission rates of gases and particulate matter being discharged into the outside atmosphere through stacks may be used to estimate the probable health nuisance, or economic damage that may result from the emission and also may be used to estimate the efficiency of control measures.

The subjects discussed include problems encountered in stack sampling, stack-gas-velocity measurement, sampling velocity measurement and time, location of sampling point, nozzles used on the sampling tube, interfering physical conditions, and types of collectors.

40 refs. and 50 completed questionnaires and 135 letters expressing interest in the project considered.


Stack design, as the term is used here, is concerned with the height and diameter of the stack, but even more it is concerned with the effective height, which may be increased by suitable changes in the shape of the top of the stack and by increasing the exit velocity of the waste gases. It considers the effects of nearby structures, and particularly those features that have an influence on the air-flow pattern near the stack, and it considers the influence of the temperature of the stack gases.

Stack design is concerned chiefly with what may be called the aerodynamic factors of air flow, as distinguished from meteorological factors, for these are the factors over which the designing engineer may have some control. The meteorological factors must be accepted as they come, but they cannot be ignored.


The subject is first treated theoretically and reports of experiments follow. Ammonia was added to the stack gases as a tracer and determined on samples taken at various distances. Smoke plumes for photography were made by injecting ammonic and hydrogen chloride vapors into the air stream, and the cloud was photographed against a cross-sectioned background. The results of the test showed that the column angles, momentum, and velocity distribution for various stack sizes are tabulated. (PHEA)


If factory stacks emitting waste gases were built 300 to 400 feet or more in height they might help considerably in preventing the accumulation of smog around areas.

At a recent New York meeting of the American Meteorological Society, studies of temperature changes in fogs were reported. These indicate a possible mechanism by which factory smokes and gases may combine with fog to form in strong concentrations at ground level.

At the Hanford Works, Wash., there is a tower 410 feet high. This is equipped to measure the temperature and wind direction and wind speed at a number of different levels from the ground to the top. Data obtained with this tower during three different fogs show that in each case, just before the fog formation, the temperature near the ground increased with elevation. A few hours later, after the fog had formed, these conditions were reversed. Then the temperatures dropped slightly in approximately the first 100 feet. For about the next 200 feet they remained approximately constant, while at the top of the tower, for about 100 feet, temperatures increased again.

It is pointed out that this has an important application to problems of air pollution. If stack gases are discharged at heights of less than a few hundred feet, below the upper regions where the air gets warmer with altitude, they will tend to settle toward the ground. This is because, during the period of fog, there is gentle vertical spreading of smoke in the air in these lower layers.

Thus it may be that with stacks high enough to get the emitted gases to the height where temperature is increasing, such settling of smog would not occur.

If this proves to be correct the information will be important not only for alleviating pollution problems now but also for preventing pollution problems in the future.


Taller smoke stacks would help to solve the smog problem in factory areas. Testing on a 410-foot tower it was found that about 300 feet from the ground the air temperature increases slightly. Gases discharged in this region are prevented from settling to the ground.


Discusses what to do about the weather in plant location and operation. Equations are given for predicting what will happen to stack gases under different conditions of stack height, wind velocity, atmospheric stability, and rate of discharge. The effect of the sun on air currents in a valley is demonstrated, with suggestions as to locations of plants; actual cases are cited.

It is practical in certain locations to study meteorological conditions to coordinate daily operations with them to reduce air pollution. Installation of control equipment to vary rate of emission is suggested to implement this coordination, and means involved in alteration of the type of discharge are given briefly. (PHEA)

Within the past 8 to 12 years the erection of a smoke stack fell into two stages: (1) Design, and (2) construction. To these two the rapidly developing requirements of air-pollution control now usually add the three more modern analyses of effect on atmosphere by wind-tunnel studies or other means, leading to a scientific determination of stack height and exit velocity; resolution of this height requirement with aviation limitations, airport proximity, and glide angle; and (5) forecasting changes that may be required in the completed stack by future developments in regulatory bodies on stack emissions. It is the purpose of this report to trace the engineering-economics of design of a typical stack for a modern, large steam boiler for phases 3, 4, and 5, that is, after such work as the wind-tunnel test. Most of the so-called practical problems of modern stack design fall here.


The fundamental purpose of these investigations has been to obtain stack designs that will give the most effective dispersion of gases and solids for existing limitations. The principal means of accomplishing this are high stacks, high gas-emission velocity, and coordination of building and stack design to minimize the effects of turbulence. As stack height is limited by aviation authorities in many cases, it becomes necessary to obtain the advantages of a high stack by the other means available. Some large modern power plants have been designed for stack-emission velocities of 120 or more feet per second.

In developing stack designs for effective gas dispersion, the objective is to cause the gases to rise as high as practical above the top of the plant structure so that it will reach higher strata during periods of atmospheric stagnation, and not be caught in the turbulence created by the stacks and adjacent buildings in high-velocity winds. (9 refs. cited)

1952


A series of four articles describes small-scale tests bases for design, and operating characteristics of smokeless flares. (APB)


Selected references in books and periodicals published during this century. (APB)


The various types of impurities given off from the cupola stack are considered. Developments and improvements in design of wet spark arresters that have taken place in recent years is presented. One of the chief disadvantages of an early design of arrester is the accelerated corrosion of the pipes owing to concentrations of sulfur compounds in the circulated water. Modifications made to an installation of this type after 5 years' practical experience are described. Town's water is used to overcome the corrosion problem, and none of the water is recirculated. The importance is emphasized of obtaining the maximum dispersion of the water and keeping water suspended in the air as long as possible. (APB)


Most economical steam usage was obtained when the steam was discharged at the top of the flare through a ring of jets. Tests on a pilot model showed that adequate steam-gas mixing with a stable flame could be obtained. A transparent flame was produced without extinguishing the fire. Details of the flared head used at Shell's Wilmington refinery are given. (APB)


When solid fuel is burned in a power-plant boiler, dust particles, usually called fly ash, are carried through the boiler and pass to and out of the stack. The dust passing out of the stack constitutes air pollution or contamination.

The problem is described, the principles involved are outlined briefly, and the equipment used for abating the nuisance is considered. The factors involved are only partly known but are being actively studied, and very definite progress has been made in the solution of the problem. (APB)


Attention is drawn to mistakes made in smoke control. Modern small-diameter chimneys, which drive smoke upward, are penalized unduly. Allowance is not made for a chimney with a good record that only occasionally emits dense smoke, nor for the effect of sun and cloud on observations. For fear of smoke notices operators dilute smoke with excess air. (APB)


A study of the dispersion of smoke, vapor, fumes, and noxious gases, from stacks is given and illustrated by tables and graphs. The study procedure, measurements, and comparison of results with published formulas are discussed. By selecting the proper diffusion coefficients, either the Sutton or Bosanquet relations may be applied to the solution of problems involving design of stacks. If the diffusion coefficients reported in the literature are used, the equation will predict average concentrations that agree within two-fold of the actual. This can be improved by better selection of coefficients. Use of dilution factors reported by Church also gave good agreement but probably cannot be expected to apply universally for 80-foot stacks, especially since they were developed for a 200-foot stack. In considering air-pollution problems, the time-average concentrations at a point, the average maximum at a point, and the maximum at a point must be considered. These represent time intervals of 1/2 to 1 hour, or more; 1 to 5 minutes; and 1 to 10 seconds, respectively. The character of the effluent and the type of problem anticipated will determine which of the concentrations will be most important. (APB)


Natural draft chimney is defined as a "no moving parts" device that converts heat energy into a flue gas pump. Investigation indicates that there is an optimum gas flow point where maximum draft is developed. At low flow rates, flues did not develop as great a stack pull for a given temperature as they did at high flow rates. This might be attributed to recirculation within the flue causing turbulence and unanticipated frictional resistance.

Organizations that have been concerned about chimneys are listed.
Lack of uniformity in regulations of cities in methods of sizing stacks is emphasized. Also the wide variation in stack sizes of different manufacturers for similar capacity boilers is mentioned. It is certainly strange that, considering the millions of stacks that have been built since man began putting a roof over his head, any universally accepted and scientifically determined method of sizing stacks is lacking.


Reduction of smoke, cinder, and fly ash from stacks of boiler plants is only one phase of air-pollution abatement. However, the present discussion is confined to ways and means of reducing smoke, cinder, and fly ash from the exhaust stacks of small coal-fired boiler plants. Such emissions can be reduced to conform with air-pollution ordinances. It is largely a problem of educating the small plant owner and operator in the benefits and necessity of cleaning up their stacks. (8 refs. cited)


The theory of natural draft, application of this theory to the performance of natural-draft chimneys, and finally translation of the theory of performance into the design of the chimney or the determination of the size of the stack are considered.

Points discussed are natural draft, total dynamic draft, size of chimney, nomenclature, and structural design. Included also are tables of chimney sizes for various chimney-gas velocities, and of economical chimney sizes.


The word "stack" means a necessary adjunct to a power or industrial plant.

There are many forms and types of stacks, the fore-runner of the mechanical-draft stack being the reliable and faithful natural-draft stack. The latter has two inherent advantages: (1) It has no moving parts and (2) it requires no power. On the other hand the mechanical-draft stack has the definite advantages of (1) flexibility, (2) adjustability to affect any rate of combustion, (3) stability under atmospheric conditions, (4) capability of any practical degree of overload without undue expenditure of energy, and (5) indispensability under certain conditions.

Each plant presents an individual problem of selection of the proper mechanical-draft system that calls for careful analysis of the many variables involved. Systems can be engineered today for any design pressure requirements, any desired degree of pressure control, self-support against any of nature's elements, or maximum thermal efficiencies with minimum fan horsepower; meanwhile research data and experience now being accumulated and recorded mean reasonable accurate predictions of stack dispersion into the atmospheric reservoir will be possible in the foreseeable future.


A local ordinance regarding air pollution in Dearborn, Mich., is discussed from the viewpoint of the Ford Motor Co. and its program for complying with the provisions of the ordinance. The code is a general one that covers all aspects of atmospheric pollution. An arrangement was made by which primary responsibility was clearly defined with only two key men, one...
in industrial hygiene and the other in plant engineering, needing to correlate closely their activities.

An orderly procedure on selecting the proper and required size of a natural-draft chimney is described. All of the operating factors are taken into consideration without relying on the old method of selecting the size from a table based only on boiler horsepower.

What is needed is a better system of sizing larger commercial and industrial, boiler house and power plant, chimneys and stacks.


The flare consists of three concentric stacks. Gas entering the base of the inside stack meets a water spray, and the mixture of gas and water vapor is ignited by two pilot lights. Burning occurs chiefly in the intermediate stack. Air is admitted on four sides of the stack. Operation is satisfactory at 180,000 cu. ft. per hr. with water injected at 60 lb. per sq. in. (APB)


First of three articles on stack heights needed for effective control of pollution by dispersion into the atmosphere.

Public authorities and the public are definitely pollution conscious today. As a result, industry is continually faced with the problem of eliminating obnoxious contaminants from plant discharges. These, of course, may be solid, liquid, or gaseous. Attention is focused entirely on the control of atmospheric pollution. More particularly, air pollution due to gaseous discharges or discharge of gases carrying particles smaller than, say, 1 micron in size, are considered.


Describes method of calculating plume rise, and shows how stack heights can be reduced under certain conditions and how advantage can be taken of the natural rise of the plume to increase dispersion of the pollutant. (APB)


The dispersion of particles is discussed, and a formula is given for calculating particle deposition. A problem on the deposition of particles discharged from stacks is calculated. (APB)


Experiments on factors in stack-gas dispersals are described and discussed. Preliminary experiments with air stream temperature control performed in a specially designed tunnel show promise. (APB)


The problems of combustion are said to have been considered by Leonardo da Vinci, who invented the modern chimney. His correction of the disturbance of smoking kitchen chimneys for the Duchess of Milan indicates that he was cognizant of the principle of "overfire air" and qualified as a smoke-regulation engineer.


Tests with six types or combinations of gas-cleaning units were carried out. Of the equipment tested only three gave stacks acceptable under existing codes: These were a sonic unit with a combined exhauster and dust separator that had water sprays, a high voltage electrical precipitator, and a pebble filter. (APB)


Causes of atmospheric pollution in United States cities are discussed. Measures to reduce pollution include improvement of flare tips, use of fog filters for scrubbing acid fumes and fumes from grease kettles, and installation of fume scrubbers for asphalt oxidizers. A catalytic device for improving combustion of stack gases, which may reduce smog, has been developed by E. J. Houdry. An account of Aurora Gasoline Co. program is given. (APB)
LEGAL ASPECTS OF AIR POLLUTION

ORDINANCES AND REGULATIONS

1882


The ordinance prohibiting the further delusion of the air of Cincinnati with smoke went into effect with the new year, and vigorous measures have been taken to secure its enforcement. The manufacturers, chief offenders against the new regulation, are willing, and even pleased, to do their part toward this great and salutary reform. According to the report of the official inspector, "they all mean what is right," and "seem anxious to know what smoke consumer to get." "In every instance," he has "been met in the kindest manner" by the proprietors of steam boilers upon whom he called to give notice of the enforcement of the new law, and he believes that "everybody being interested in having the nuisance of soot abated, will do his best to that end, and the result will prove satisfactory to all concerned. No doubt a part of this good feeling is due to the fact that the inspector, but the main portion must be attributed to that admirable public spirit so characteristic of Cincinnati, which seems to influence all citizens alike, and to take precedence in their minds over selfish interests of considerable importance.


The Cincinnati inspector of steam boilers has made a report, after 2 months' service, in which he expresses the conviction that the owners of steam boilers generally are well disposed toward the new law for smoke abatement, but that difficulty is still found in obtaining a smoke-consuming appliance that will fully answer the purpose for which it is intended. Twenty-three different devices are in use in the city, all of which have been examined, but none have been found entirely satisfactory. With careful management some of them would save from 75 to 90 percent of the unconsidered carbon now wasted, and improvements will undoubtedly be made in time if the demand for them continues. Four hundred owners of boilers have been notified to cease discharging smoke into the air, but their goodwill toward the cause is such that not a single prosecution has yet been entered. The engineers and firemen, as might be expected, show the usual obstinate resistance of the ignorant to any innovation, but those who will have to pay for the introduction of smoke consumers are unanimous in their wish to do their part toward the general good.


The Cincinnati smoke inspector has at last been compelled to use the power committed to him in bringing to account a rebellious citizen who refused to purchase or use a smoke-consuming appliance as the law required. This is the first case of the kind. The progress of the case will be watched with interest, as whatever question there may be about the validity of the ordinance against smoke will be settled for the future by the decision; and if this supports the law the inspector's hands will be materially strengthened for his good work. In some places it is reported that the engineers, either willfully or through forgetfulness, do not use the smoke-consuming apparatus provided for them, and the inspector intends to deal summarily with them unless they begin quickly to follow the prescribed rules.


The inspector of Cincinnati still is working for smoke abatement and finds, as at first, the manufacturers almost without exception, disposed to second his efforts as far as possible. Some interesting observations have been made, for instance, in steam boilers where a uniform power is required, there is little or no difficulty in introducing effective smoke-consuming devices; but where the heat must necessarily be varied at different times the task is much more difficult. Among the culprits brought before the courts for violation of the ordinances was one who had tried two appliances, and was ready to introduce a third if the inspector should require it, but felt somewhat aggrieved, and with reason, because the inspector refused to recommend any particular device but condemned successively all that he put in. It would of course be a delicate matter for the inspector to urge the general adoption of any special appliance on his own responsibility, but if he could be sustained by the opinion of a commission of experts, authorized to examine all inventions offered and to reject entirely the unsatisfactory ones, a great deal of money might be saved to the boiler-owners, which is now wasted in fruitless experiments, and the persons who are now encouraged to incur expense in the manufacture of worthless articles would have no reason to be sorry if their true character could be authoritatively fixed before any considerable amounts had been invested in them.


The City Council of Montreal, one of the most conservative cities on the western continent, has passed an ordinance making it a misdemeanor, to be punished by fine or imprisonment, for any person to suffer or maintain upon his premises any fireplace or chimney, except the chimney of a private dwelling-house, so constructed as not to consume the smoke arising from the fuel burnt therein; and every proprietor, owner, or tenant of any engine, steam-boiler, factory, chemical works, or other manufacturing establishment is to be compelled, upon notice from the inspector of boilers, to provide his furnaces with apparatus that will effectually consume the smoke arising therefrom. Another regulation is added which is quite new, to the effect that the proprietor of any house or building hereafter erected, the chimney of which shall not be more than 12 feet horizontally distant from any other chimney having a higher elevation, shall be liable for the expense to carry his chimney at least 6 feet above the apex or roof of the building possessing the high chimney; and the proprietor of a high building erected beside a lower one already standing shall carry up at his own expense all the chimneys of the lower house that are less than 12 feet away from his to the same height with his own.


Discusses an address by Redner before the Technical Health Association, in which he requested that attention be paid to air, similar to that paid to water, soil, and fire.

Redner's address however referred to investigations on how to keep the air pure legally rather than a study of measures to purify air or prevent pollution.

In spite of the favorable result of Tyndall's experiments, which showed clearly the pollution of the air,
Industry wanted to be convinced that the reduction of air pollution would at least cost it no money. It is not the business of the State to afford industry such assurance or to make its measures for the common good dependent on the willingness of industry to be persuaded. The legal aspects are discussed and reference is made to the various laws passed in England to control air pollution.

1888


Refers to orders issued by several city authorities to prevent annoyance to the inhabitants from smoke and soot from furnaces. The complaint is made that these orders are unfair to some industries and favorable to others. Local regulations for the city of Dresden are quoted and the statement made that sooner or later such regulations are to be expected in Berlin.

1889


This paper supplements the paper on Smoke Nuisance that was read to the Congress at its meeting in Bolton, 2 years ago. It is intended to discuss the result of the movement recommencing after many years' repose, and to suggest a way of getting over the almost insurmountable difficulties of interfering with powerful people acting illegally, which has been long tolerated. The evil is in the administration of the Public Health Act.

1890


Editorial, reviewing report of Chief Inspector of Alkali Works, and calling attention to needed enforcement of regulations. (MIH—Bib.)

1891


In the discussion in the House of Commons on the local Government Board vote, it was said that the law was in an anomalous condition. A number of alkali-works are exempted from discharging noxious vapors, but many smaller works using the products made at the larger are not prevented. If the inspector can induce the smaller works to consume these noxious gases then they come under the Act.

1892


The committee reported that the few years of comparative freedom from coal smoke, owing to the use of natural gas, had given the people of the Pittsburgh community a strong desire to avoid the evils menacing from the rapidly increasing consumption of soft coal. Causes of smoke and methods of control, with a brief history of smoke prevention, were discussed.

Ordinances of Chicago, Cincinnati, and Cleveled and Birmingham, England, and a proposed ordinance for Pittsburgh were considered.


Considers chiefly the working of the Alkali Act and its amendments regulating escape of hydrochloric acid gas into the atmosphere. (MIH—Bib.)


Although it seems to be generally agreed that black smoke in particular is dangerous, from a hygienic point of view, it is not certain that the case against black smoke has been made. There is a growing conviction that the gray smoke of the household grate is really a more deleterious product. The fire, being made up last a long time, produces smoke consisting largely of oily hydrocarbons, which are more injurious to organisms than the black smoke consisting of hydrogen and free carbon that is given off from the high temperatures of the boilers.

However, all smoke contains sulfuric acid, the agent that has destroyed the vegetation in such large districts as Lancashire and southern Spain.

The saving clause under the Smoke Clauses of the Public Health Act, 1875, read as follows: "The Court shall hold that no nuisance is created within the meaning of this Act, if it is satisfied that such fireplace or furnace is constructed in such manner as to consume as far as practicable, having regard to the nature of the manufacture or trade, all smoke arising therefrom, and that such fireplace or furnace has been carefully attended to by the person having charge thereof."

The weather should be considered in case of a smoke prosecution. The smoke problem, as the direct cause of the injurious fogs in London, is one worthy of the attention of our foremost scientific men.

The following resolution was submitted: That where the smoke clauses are enforced the inspector should be a chemical engineer or other person competent to carry out the spirit of the Act.

It was suggested in the discussion that pollution of the atmosphere in many instances arose from the inferiority of the fuel used, the want of smoke-consuming grates, and the absence of efficient supervision of the lighting and management of the furnaces.

It was a question of degree, and when the limit had been discovered beyond which smoke was harmful to the community, then pollutions beyond that limit must be presented. If necessary, the manufacturers would have to be harrassed and sent from one place to another until they found a way to utilize the waste products that they sent out into the air and bring them to some useful purpose as was done with the hydrochloric acid, owing to the legislation.

Pollution arising from cement works was so objectionable that when the wind was blowing from the works the inhabitants had to close their windows a mile away. There was no black smoke but a smell like the smell from brick works which caused people a mile away to cough and sneeze.

At Southampton they no longer had any nuisance from these cement works. They had a kind of cremator at the works and the fumes passing over this were virtually consumed. During the last few years they had had no complaint to make of any annoyance or nuisance from these cement works.

To various suggestions that had been made, the reply was that the law should be administered equally in all cases. There ought also to be a proper inspector to decide if the nuisance could be prevented.

1898


Experience with the Chicago ordinance is reviewed briefly. The protests generally found were not so much
against the ordinance as against the way it was enforced. It is suggested that the inspector be compelled to keep an open book of record.

The statement was made that a "smoke ordinance" should be enforced as ordinary laws are enforced. Instead of putting a man on the roof of a high building, with a spy-glass, to watch chimneys, it was believed that men should be sent out to visit the boiler rooms, and that these men should be competent to suggest and advise what is best to do.

Editorial comment on the indictment of the Long Island Railway Co. for the smoke nuisance. (MIR—Bib.)

1899


The agitation regarding smoke nuisance resulted in the birth of an association formed to assist local authorities in suppressing this growing evil.

The existing law is summarized, comprising a review of certain Acts of Parliament and with some of the more important cases that have been decided thereunder.

(1) Discusses the right of a private individual to institute civil proceedings.

(2) Railway Clauses Consolidation Act of 1845.

(3) The Towns Improvement Clauses Act of 1847.

This was only applicable to such towns and districts as might thereafter be comprised in any act of Parliament with which it was specially incorporated. It was upon this Act that local bylaws were founded.

(4) Act to Abate the Nuisance Arising from the Smoke of Furnaces in the Metropolis and from Steam Vessels above London Bridge passed in 1853, and the Nuisances Removal Act of 1855.

These have both been repealed by the Public Health (London) Act of 1891. These referred only to London.

(5) The first enactment that extended to the whole of England, with the exception of London, was the Public Health Act of 1875.

(6) In 1878 the traction engine was made subject to Parliamentary control.

(7) Section 24 of the Public Health (London) Act, 1891, which is identical with Section 91 (7) of the Public Health Act, 1875, is perhaps the most important statutory provision upon the subject of nuisances arising from smoke. By that section it was provided that any fireplace or furnace that does not as far as practicable consume the smoke arising from the combustible used therein, and which is used for working engines by steam, or in any mill, factory, dyehouse, brewery, bakehouse, or gasworks, or in any manufacturing or trade process whatsoever, and any chimney (not being the chimney of a private dwelling house) sending forth black smoke in such quantity as to be a nuisance, shall be deemed to be a nuisance liable to be dealt with summarily in manner provided by this Act.

A society formed to encourage the invention and application of smoke consumers cannot fail to receive hearty support both from the manufacturers who desire to economize their fuel, and from the general public who appreciate the blessings of a pure and unadulterated atmosphere.

Appendix to report of committee on revision of standard code for conducting steam-boiler trials. (MIR—Bib.)

1900


A rather peculiar combination of engineering and judiciary judgment is afforded by a recent legal decision that declares the smoke ordinance in Denver, Colo., unconstitutional. The decision is based on the opinion that no device exists for the adequate prevention of smoke as provided in the ordinance.


Deals principally with British law on the subject. (MIR—Bib.)

1901


Presents brief summary of the laws governing emission of smoke in London. Specific cases are cited.

1902


Principally a discussion of the Acts of Parliament mentioned, with comments upon the intent of the phraseology and the changes from the old Acts.

1903


Reviews features of municipal smoke ordinance of 1901. (MIR—Bib.)

1905


Advice is given by smoke inspector of Indianapolis on framing and enforcement of smoke ordinances and on design and alteration of furnaces, and the classes of smoke-preventing appliances are considered briefly. Closes with a brief review of literature on the subject. (MIR—Bib.)

1906


The legislature has plenary power to declare the discharge of dense smoke in populous communities a nuisance per se.

Presents a discussion on the decision of the Supreme Court of Missouri (State v. Tower, 84 S. W. Rep. 10) sustaining the Act of the Missouri legislature directed against the smoke nuisance in all cities of the State of 100,000 inhabitants or more. The decision is in line with the enlightened judicial opinions that recognize the plenary power of the legislature to declare those things resulting in annoyance, inconvenience, and discomfiture as nuisances that were not recognized as such under the general principles of the common law.

(2) Reasonableness of such legislation as exercised. "Every man holds his property subject to the maxim that he must so use it as not to injure his neighbor. Nothing in that amendment (14th, United States Constitution) has shorn the States of their police power to prohibit or regulate unlawful trades and occupations. Nothing in the Constitution of the United States or this State secures to any man the right to maintain a nuisance to the discomfort and peril of the health of his neighbor."

(3) Classification and discrimination. The discriminations open to objection are those where persons en-
gaged in the same business are subject to different restrictions or are held entitled to different privileges under the same conditions. (4) Defense where smoke cannot be abated by the application of a device. In any suit or proceeding it shall be for the defense if the violation thereof shall show to the satisfaction of the jury or court trying the facts that there is no known practical device, appliance, means or method by application of which to his building, establishment, or premises the emission or discharge of the dense smoke complained of in that proceeding could have been prevented. (5) Furnace Conditions Favorable to Smoke Abatement. Smoke abatement, which simply is complete combustion and utilization of all heat-producing parts of the coal, is economy to the plant owner. Thus it follows that the interests of the private owner and the public health, comfort, and convenience are parallel. As the fundamental conditions to perfect combustion is in the furnace and boiler : the furnaces, the foundation of smoke abatement is in the original installation. (6) Laws applicable to specified class of cities. A statute that divides municipal corporations into classes, according to population, and legislation adapted to the different classes is regarded as general in its nature and not violative of the constitutional provisions against the enactment of special or local laws. Population and not geographical distinction should control the classification. 3581. MUNICIPAL JOURNAL AND ENGINEER. Smoke Nuisance in Vienna. Vol. 19, 1905, p. 75. In recognition of the fact that the present laws were inadequate for smoke control, the following provision had been inserted in the draft of the new building regulations of Vienna: In smoke-producing plants no danger of fire, or sanitary evil, and no material nuisance to the neighborhood shall be allowed to be created. All plants to be erected in the future are to be constructed and used so that no such annoyances shall exist, and should such annoyances arise the owner of the plant must provide the necessary remedy at his own expense. In case changes are made in the neighborhood whereby a plant already constructed becomes a source of danger from fire, a sanitary evil, or a material nuisance, it shall be the business of the owner of the plant to provide a remedy at his own expense. 3582. SANITARY RECORD AND JOURNAL OF SANITARY AND MUNICIPAL ENGINEERING. Reports on the Laws in Force in Certain Foreign Countries in Regard to the Emission of Smoke From Chimneys. Vol. 35, 1905, pp. 29-294. Presents reports from Austria, Bavaria, Belgium, France, Germany, Hungary, Italy, Netherlands, Saxony-Coburg and Gotha, Switzerland, United States, and Wurttemberg. (MIR—Bib.) 1906 3583. CHURCH, LAWRENCE W. Powers and Duties in the Matter of Smoke Abatement. Conference on Smoke Abatement. Jour. Roy. San. Inst., Trans., vol. 27, 1906, pp. 229-229. The results are given of 295 reports of the extent that local authorities have succeeded in solving the problem of smoke abatement. Under the provisions of the Public Health Act, the extent of enforcement of the various local authorities is disappointing. The inactivity of the part of some of the councils named is manifestly due to fundamental misconception of the subject. The excuse given on behalf of Tipton may be cited as a typical illustration of this assumption. The "council will not take any steps in the matter as the members are too glad to have the smoke as evidence of renewed trade." If every sanitary authority could be brought to recognize that the emission of black smoke is an ocular proof of an avoidable waste of fuel which, as has been abundantly demonstrated, can be remedied to the pecuniary advantage of the employer, as well as to the comfort of the public, it might, perhaps, realize the desirability, from all points of view, of performing its statutory duties in the matter. In some districts the services of the police are utilized in enforcing the regulations against the emission of smoke. Information is included in smoke reports on the number of prosecutions against offenders. To sum up, the returns disclose that, while the black-smoke evil is very generally felt and deplored, relatively few local authorities have in the past taken a decided stand in the matter and that, while this inactivity may sometimes be traced to apathy, it is more often due not to any inclination to evade responsibility but to a feeling of hopelessness in view of the uncertainty of obtaining convictions. Where authorities have taken a decided stand, however, even with the imperfect machinery at present available for suppressing smoke nuisances, it is only fair to say that they claim to have diminished the evil. Little improvement or zeal can be looked for until the law is simplified and extended and a more summary and effective method of procedure provided. It is, perhaps, not too much to hope that the local government board, in view of the suggestions made by important corporations, may see its way to change the local authorities, in the immediate future, with the further powers for which they ask. Discusses the desirability of amending the Public Health (London) Act, 1891, to omit or define the word "black" to make easier the administration of the law against the emission of smoke. A suggestion that seemed to meet with general approval was to amend the act to read "black smoke or smoke in such quantity as to be a nuisance." Comments are made on smoke-abatement legislation in France, Germany, and the United States. The most drastic legislation was that of Dresden, Germany, which forbade black smoke entirely and colored (visible) smoke almost entirely. 3584. DEE, T. G. Smoke Abatement from the Sanitary Inspector's Point of View. Jour. Roy. San. Inst., Trans., vol. 27, 1906, pp. 238-241. Reviews important patents on typical preventive devices. Shows that the definition of a nuisance resulting from black smoke depends on two factors, the density of the smoke and the duration of the emissions. (MIR—Bib.) 3585. ELECTRICAL REVIEW. Smoke and Smoke Prevention. Vol. 68, 1906, pp. 335-336. A symposium on smoke and smoke prevention by the New York section of the Society of Chemical Industry on Feb. 23, 1906, is reported briefly. Examples of the State and city regulations to control smoke are cited. Several methods of smoke prevention are mentioned, including a device for filtering smoke that did not prove entirely satisfactory. 3586. HURST, JOSEPH. English Law Relating to the Emission of Smoke From Chimneys. Jour. Roy. San. Inst., Trans., vol. 27, 1906, pp. 226-229. Smoke nuisance may be dealt with, under English law, as a nuisance at common law, as an offense against the national Public Health Act of 1875, or as an offense against the London Public Health Act of 1891. (MIR—Bib.)

When smoke is a necessary nuisance and when it is a statutory nuisance are discussed briefly. The necessary smoke would be the uniform standard allowed, and above this amount it would be a nuisance within the meaning of the smoke law. To ascertain what is and what is not a statutory nuisance requires a board of experts. The work of such a board would be of great value to public health, manufacturers, and owners of appliances.


It is suggested that three standards should be established before inhabitants may be said to be suffering in health or in amenity from a smoke-polluted air. The atmosphere of a town cannot be compared fairly with that of a purely residential town, still less with a country village or hamlet. A suitable standard for city or town air, such as is in force for the amount of water and fat in milk, the quantity of butter in margarine, the quality of drugs, and exhalations from works coming under the Alkali Act, has not even been given serious consideration. Yet there is abundant evidence that a smoky atmosphere is detrimental to health, conducive to depression, and destructive to plant life as well as to building material. It is suggested that the Alkali Act should be amended. Legislation against the smoke evil should be impartial, precise, and operate equally and fairly.

1907


Section 1. The emission or discharge into the open air of dense smoke within the corporate limits of cities of this State is hereby declared to be public nuisance.

Section 2. All cities to which the provisions of this Act are applicable are hereby empowered to enact all necessary or desirable ordinances not inconsistent with the provisions herein nor any general law of this State in order to carry out the provisions of this Act.

Section 3. All acts or parts of acts inconsistent with this Act, or any part thereof, are hereby repealed.

1908


Describes Chicago's policy of allowing only officially approved installations. (MIR—Bib.)

3592. CANADIAN MUNICIPAL JOURNAL. Preventing Smoke. Vol. 4, 1908, pp. 221-222.


Plans of smoke inspectors of Chicago, giving special attention to the installation and type of proper firing equipment. (MIR—Bib.)


Violations of the smoke ordinance have become so flagrant and numerous at Indianapolis that a committee of the Board of Trade is to investigate the question. The smoke statistician has sent out blanks for reports on the kind of coal used by factory owners and large buildings. The blanks call for reports on the following kinds of coal: Indiana; Kanawha, W. Va.; Pocahontas, W. Va.; Ohio; Kentucky; Ohio; Pittsburgh, anthracite. The Board of Trade committee says it is the intention to gain official information that will show to some extent just what kinds and grades of coal are responsible for the great quantities of dense black smoke in Indianapolis. A meeting was held recently at which the Board of Trade, coal operators, and manufacturers decided to investigate smoke conditions, and the steps now being taken are the result of that meeting.

3595. ENGINEERING RECORD. Smoke Prevention at Newark, New Jersey. Vol. 57, 1908, pp. 72-73.

Creation of city department of smoke abatement and Ordinance of December 10, 1906, to regulate the emission of smoke from chimneys in which violations were based on a color scale for determination of the nuisance. Legal difficulties were encountered, and so on May 22, 1907, a new ordinance was adopted in which color scale was abandoned and different methods adopted. Sections 1 to 5 of this ordinance are explained in detail.


A large part of the success of smoke abatement depends upon the attitude of the courts in the various States where such ordinances are enforced. Causes and prevention of smoke are discussed. The most hopeful sign of the time is the strong public sentiment that demands smoke abatement.


A large part of the success of smoke abatement depends upon the attitude of the courts in the various States where such ordinances are enforced. Causes and prevention of smoke are discussed. The most hopeful sign of the time is the strong public sentiment that demands smoke abatement.


Describes practice followed in Chicago and gives rules for construction of furnaces to meet requirements of Smoke Department. (MIR—Bib.)


Describes work of Chicago Department, discussing supervision of fuel-burning plants. (MIR—Bib.)


The statement is made that the time has come when the regulation of the "Smoke Nuisance" is a necessary part of the law of every progressive community. The art of smoke prevention has reached a point where such regulation is entirely reasonable. It is recognized by manufacturers that smoke means waste and incomplete combustion and that the gases escaping from blast furnaces are byproducts that may be utilized to advantage in generating power. A smoky chimney is not only an evidence of bad citizenship but of bad management.

Smoke legislation is a comparatively new development of the law, but the principles that govern valid legislation are not new. Those principles are old and familiar, and are to be applied to this as to any other branch of the law.

A discussion is presented on actual cases regarding emission of dense smoke from stacks in District of Columbia, New York, Pennsylvania, Michigan, Indiana, Indiana,
Ohio, Delaware, Massachusetts, Illinois, Minnesota, New Jersey, Missouri, and Alabama.

1909


Every individual has the right to have the air distributed over his property and habitation in its natural condition, that is, free from artificial impurities. In fact it may be stated that no one has the right to interfere with the distribution and amount of pure air that flows over another's land any more than he has to interfere with his neighbor's soil. This right is strictly a natural one, and every use of property that causes an unwarrantable impregnation of the air with foreign substances to the detriment of another is a nuisance and actionable as such. The air must be as free and pure as can be reasonably expected.

Based largely on the preceding, it is laid down broadly as a general rule in law that any act, omission, or use of property that results in polluting the atmosphere with noxious or offensive gases or vapors, thereby causing material physical discomfort and annoyance to persons residing in the vicinity or injury to their health or property, is a nuisance. This rule has been supported by decisions in Delaware, Illinois, Kentucky, Maryland, Pennsylvania, Texas, and Wisconsin.

What constitutes a nuisance is discussed at some length with examples of lawsuits for damages from smoke and fumes emitted by industrial plants. Various measures for abatement of the smoke nuisance and their effectiveness are mentioned.

A brief discussion of foreign laws concerned with smoke abatement is included. (47 refs. cited)


Reviews rulings under common law and under statute. Suggests tax on chimneys. (MII—Bib.)

1910


The economy resulting from smoke abatement is a potent argument in its favor. The legal status, different phases of the smoke problem including the question of what constitutes a nuisance, and the usual gases that give rise to complaints in manufacturing localities are discussed. Explains cases of Federal jurisdiction (when a manufactory of one State generates smoke that is complained of in adjoining State). Foreign laws of importance are dealt with briefly.

It is concluded that the main solution of the "fume question" and "air pollution" would seem to be in the enforced use of waste-reclaiming devices by the enforcement of a Federal law regulating the amount of waste gases to be permitted to pass into the air, but laws do not execute themselves, and strict administration, sufficient appropriations for the determination of facts, enlightenment of the public mind as to the effects of noxious industrial emanations, and civic interest would all be absolutely required for the enforcement of such a law.


The requirements of the statute on dense smoke passed by the Massachusetts Legislature are discussed and explained. Presents table showing the density of smoke in accordance with the Ringelmann chart.


The smoke law for improving smoke conditions in Boston and its immediate surroundings is discussed.

The law, passed by the Massachusetts Legislature, took effect July 1, 1910.

The bill presents several original features not previously included in smoke legislation in the United States, and as far as known in other countries. Among these features is the classification of stacks according to the inside diameter at the top.

The provisions of the law are given in detail.


Editorial discussion of suits and decisions regarding the suppression of smelter fumes. (MII—Bib.)


The Proposed Act for the Abatement of the Smoke Nuisance in the City of Boston and Vicinity, which was to take effect on June 1, 1910, is considered briefly. The act provides for the creation of the Metropolitan Board for the Abatement of Smoke; classifies chimney; outlines the manner in which the density of smoke is to be established; and prescribes the degrees of smoke that shall be prohibited from issuing from chimneys of the different classes.

1911


It is claimed that the Boston smoke law has led to abatement of the smoke issuing from locomotives and factory stacks without hardship for the owners of the stacks.

The smoke inspector is not only an investigator and instructor but a prosecuting attorney where violations of the smoke law occur. He has not brought offending owners and engineers into court to pay fines; he has taught firemen and engineers how to fire their boilers scientifically.


A committee on smoke abatement was constituted in the Chamber of Commerce and a practical and enforceable smoke ordinance was drafted and passed, after some delay, by the City Councils.

A new bureau was created to enforce the ordinance and a head for the bureau was nominated by the Chamber of Commerce on request. During the short period of his administration more than 500 improved devices were installed in establishments producing the smoke. The chief of the Smoke Inspection Bureau for the year just ended reports that during this period the volume of objectionable smoke was reduced from 1,500 stacks.


The laws to control smoke and the progress made in its abatement are outlined.

To measure the effect on health, the death rate for different years is used, although it is admitted that this is an imperfect criterion. Tables for annual death rate for Manchester for 1838 to 1910 show a decrease from 35.8 per 1,000 population to 25.24 per 1,000.

The relative mortality from chest diseases for Manchester is compared with that for other towns, and a record of sunshine is also given. The death rates from pulmonary disease follow more closely the social circumstances than the atmospheric conditions of districts.

Fogs do not allow the dispersal of sulfur dioxide. The increased rate of deaths from respiratory disease follows fog. The increase in mortality from bronchitis, like the increase from phthisis, follows more closely on the fog than does that from pneumonia. (USPHS)
The status of smoke abatement in the cities of the United States in 1912 is outlined briefly. The data were obtained by circulars of inquiry sent by the Bureau of Mines to officials and antismoke organizations of the principal cities. In the information supplied by the smoke inspectors or other officials, the cities were divided according to population into three groups, namely, those having fewer than 50,000 inhabitants, those having 50,000 to 200,000 inhabitants, and those having over 200,000 inhabitants.

A brief statement is given concerning the work of smoke abatement in some of the more important cities in the groups circularized. Each of the cities mentioned has some form of ordinance to regulate the production or emission of dense smoke, and some of the requirements of the various ordinances are quoted.

Two specimen forms of smoke ordinances, giving certain features desirable for a city of 200,000 population or over and another for a smaller city, are included.

An appendix gives the exact phraseology of the ordinance in Chicago (1912) to Chicago, Pittsburgh, Des Moines, Milwaukee, and Los Angeles and the State acts applicable to the city of Boston.

The increased attention that is now being given on both sides of the Atlantic to the subject of smoke abatement and the success that has attended the efforts of the public health authorities of many important cities and centers of manufacturing industry to improve the purity of the atmosphere render comparison of the laws in force in different countries against the pollution of the air by black smoke of especial interest at present.

The American laws against smoke emission vary greatly in the different States and cities.

The same condition of affairs exists to a lesser extent in Europe. In certain cities and districts the laws against smoke are stringent and vigorously enforced, while in others considerable laxity is shown, and proceedings against manufacturers for excessive smoke emission are rarely undertaken and rarely successful.

Although the laws relating to excessive smoke emission may be extremely faulty, and although there may be also great laxity with regard to their enforcement in many places, those who are earnestly attempting to improve the atmosphere of the chief centers of population and industry in this and other countries cannot afford to be entirely ignorant of the legal side of smoke abatement. Therefore the legal position in regard to smoke abatement in Great Britain is reviewed, and some details are given also of the proposed amendment and consolidation of the English Acts relating to smoke abatement. The state of the law in Austria, Belgium, France (Paris) Germany (including Bavaria, Sax Coburg Gotha, and Wurttemberg), Hungary, Italy, Netherlands, Switzerland, and the United States, is reviewed.

Editorial, suggesting smoke inspection work by city authorities, in line with that of Chicago. (MIR—Bib.)


Total smoke emitted during day to be observed, rather than maximum density for short periods. (MIR—Bib.)


Reprint of article in Salt Lake City newspaper. Deals with smoke nuisance in general, and suggests legislation for Salt Lake City. (MIR—Bib.)


The Court of Special Sessions of New York City, in the case of the State against the New York Edison Co., has decided that the provision of the sanitary code of the board of health prohibiting the discharge of "dense smoke" from buildings, vessels, and stationary or locomotive engines within the city limits is "unreasonable and arbitrary because of its unqualified and sweeping character, condemning as a nuisance a thing that may or may not be a nuisance, and because it makes no provision for cases where compliance is impossible." The court further states that the present ordinance, prohibiting, as it does, emission of dense smoke, irrespective of reasonable definitions, limitations, and qualifications, is a restriction upon the use of private property and repugnant to the provisions of the Federal and State constitutions, that no person shall be deprived of his liberty or property without due process of law.

Such an outcome was to have been expected under the city's present regulations governing the production of smoke, for who is there to draw the line between "dense" smoke and smoke that is not "dense" unless there be some definite basis by which the density of smoke may be measured? The intent of the sanitary code is excellent, but its wording is unfortunate in not defining the term "dense smoke" and in not recognizing that a reasonable production of smoke is essential to the conduct of industrial enterprises. The ruling of the court, therefore, makes the section of the sanitary code as it now stands void and inoperative. It is, perhaps, just as well for New York that such is the outcome of the case, for now the city may look forward to a revision of its rules and the passage of a workable ordinance.

It is interesting at this time to reflect that Boston in 1910 was confronted with a problem similar to the one that New York must now solve. The Boston ordinance contained a "dark or dense-gray-smoke" Joker, and it was not until the Massachusetts Legislature provided for classification of smoke densities by means of the Rieglmann smoke chart and permitted emission of dense smoke for certain brief periods at definite intervals that regulation of the smoke nuisance could be carried out effectively. Such a law as this, instead of the present one, is what New York needs. In fact, the promise of a new ordinance is the silver lining in the sooty cloud that seemingly is rolling onward to envelop New York since the ban on smoke has been lifted temporarily.

Notes on proposed vigorous campaign, prosecuting all violators of smoke provisions of the sanitary code. (MIR—Bib.)


Comment on Cleveland Smoke Inspector’s report for 1912, with abstract of report. (MIR—Bib.)


Series of comparisons by city smoke inspector; cooperation by railroad; average of about 20 plants per month reconstructed. (MIR—Bib.)


Discusses great studies made in up-to-date smoke regulation in Pittsburgh after the smoke ordinance was changed to a new one. The specific purpose of the smoke ordinance is to regulate the smoke nuisance. It is suggested that prosecutions in court for violations of the smoke ordinance should be the last resort. That results being attained is indicated by remarks of visitors regarding the diminishing smoke; the records of the Weather Bureau for the years 1912-16 show a continual annual reduction in number of days of dense smoke and light smoke. Many changes were made from handling to stoker equipment; railroads received marked attention with resulting smokeless stacks; and moral suasion was brought to bear on offenders of the smoke ordinance.


Industrial life and with it the very existence of a great many of our cities is predicated on coal consumption. It is surprising that cities have found great difficulty in solving a problem that arises out of coal consumption—the smoke problem.

American cities have long recognized this problem and have attempted to cope with it. Chicago passed the first general smoke ordinance in April 1881, and Cincinnati enacted one in November of the same year. Legislative enactments have gone on until some 75 American cities have enacted such ordinances. Figures are given showing the cost of smoke to the community.


The following points are covered:

Limiting time to which the emission of smoke may be permitted; smoke inspector's appointment and duties; the responsibility of that Board of Gas and Electric Light Commissioners to enforce the provisions of the act, and penalties to be imposed on violators.


The production or emission within the city, of smoke, the density, or shade of which is equal to or greater than Number 3 of the Ringelmann chart from any stack, except that of a locomotive or steamboat, for a period or periods aggregating 2 minutes or more in any period of 15 minutes, and the emission of such smoke from any locomotive or steamboat for a period or periods aggregating 1 minute or more in any period of 8 minutes, except for a period not to exceed 20 consecutive minutes, not to exceed once a day, while a new fire is being built therein, is hereby prohibited. This provision does not apply to the operation of fire engines or fireboats of the Department of Public Safety of the City of Buffalo.


The Division of Air Conditions Control is charged with the responsibility for the prevention and abatement of smoke, gases, and fumes. Regulations—abatement—penalty for emission of dense smoke are discussed.


3626. ———. Cleveland, Ohio: Ordinance of December 13, 1921, to Provide for Abatement of Smoke, Cleveland, Ohio. Man. Smoke and Boiler Ord. and Requirements, 1922 ed., pp. 115-117. Duties of the Commissioner of Smoke Inspection are listed. Nuisance is described and abatement is specified.


Provides for the inspection, regulation, and abatement of smoke in the City of Columbus and of the plants causing the emission of the same.


The abatement and prevention of smoke are provided for; an advisory commission to the Building Inspector is created; and a deputy smoke inspector is provided for; the respective duties thereof are defined, and penalties for the violation thereof are indicated.


The emission of dense smoke within the city of Des Moines is declared a public nuisance and the same prohibited; provision is made for the appointment of a smoke inspector, fixing his compensation and the fees of his office.


The ordinance declares that emission of dense black or gray smoke from any smokestack or chimney used in connection with any steam boiler, locomotive, or furnace of any description, in any apartment house, building, boat, or any other structure, or in any building used as a factory, or for any purpose of trade, or for any purpose whatever within the corporate limits of the city of Detroit, shall be a public nuisance per se.

Duties of the smoke inspector and penalties for violations of the rules are listed.


The emission of dense smoke within the city of Duluth is declared to be a public nuisance and is prohibited.


Provides for smoke inspection and abatement in the city of Grand Rapids and provides for the repeal of all ordinances inconsistent therewith.


Dense and unnecessary smoke, fuel combustion apparatus, etc., are defined; the bureau of smoke regulation and the office of bureau chief are created, and the latter's salary is fixed, and his duties defined; the emission of smoke is regulated, and plans are approved
for the construction, installation, reconstruction, extension, alteration, or repair of fuel combustion apparatus and for issuance of permits therefor; provision is made for penalties for violations, and for repealing inconsistent ordinances.


The emission of dense black or gray smoke from any smokestack or chimney used in connection with any stationary steam boiler, locomotive, or furnace of any description within the corporate limits of the city of Indianapolis, in any apartment house, office building, hotel, theater, place of public amusement, school building, institution, locomotive, or any other structure in the city of Indianapolis, or in any building used as a factory, or for any purpose of trade, or for any other purpose whatever except as a private residence, shall be deemed and is hereby declared to be a public nuisance.


Provides for the abatement of “dense-smoke” nuisance, for the appointment of a smoke-abatement commission and a smoke inspector, for regulating the construction of and for inspecting smoke-producing plants, and for proper ventilation of plants producing power and heat, and fixing penalties for the violation thereof.


The discharge of smoke from flues, chimneys, smokestacks, or other structures or appliances from which smoke is discharged in the city of Los Angeles is regulated and penalties are provided for violators.


An ordinance to prevent the emission of soot, cinders, acid or other fumes detrimental to health, or dense smoke from smokestacks, chimneys, and all other smoke-emitting stacks within the city of Louisville, including locomotives, railroad engines, engines used and employed in house and street cleaning work, and other engines in the city of Louisville.


An ordinance to prohibit the discharge of dense smoke in covered buildings. The discharge of dense smoke is covered but no provision is made for jurisdiction over the requirements of boilers, furnaces, etc.


This ordinance relates to and regulates the construction, operation, and use of smokestacks and other apparatus connected with smokestacks, and the operation of portable boilers, in connection with steam shovels, dredges, excavators, ditching machines, concrete mixers, hoisting rigs, and other devices in Minneapolis.


The inspector of boilers under the fire department's jurisdiction to enforce the smoke-prevention regulations.


The emission of dense smoke from any smokestack or chimney used in connection with any stationary steam boiler, locomotive, or furnace of any description, within the corporate limits of the city of Nashville (except for a period of 6 minutes in any 1 hour during which the firebox or fireboxes are being cleaned out and new fire or fires being built therein), in any apartment house, office building, hotel, theater, place of public amusement, school building, institution, locomotive, steamboat, or any other structure, or in any building used as a factory or for any purpose of trade, or for any other purpose whatever except as a private residence, shall be deemed, and is hereby declared to be, a public nuisance.


Newark has no city ordinance for the regulation and requirements of boilers or furnaces. The ordinance relates to and regulates the emission of dense smoke containing soot from chimneys, stacks, and flues, or from far kettles and other contrivances within the corporate limits of the city of Newark. It creates the department of smoke abatement and the position of smoke inspector, prescribing the duties and salary and the manner in which his work shall be done, controlled, and supervised and provides penalties for the violation of this ordinance.


New Orleans has no specific smoke-abatement ordinance, or requirements for smoke consuming devices. However, section 88 specifies the height of chimneys and states that chimneys (of forges and furnaces connected with steam plants, used in factories of every description, hotels, office buildings, laundries, and bakeries) shall have caps on them so constructed as to prevent cinders and soot from falling on neighboring buildings.


The discharge of dense smoke is covered but no provision is made for jurisdiction over the requirements of boilers, furnaces, etc.


This ordinance specifies the qualifications and duties of the smoke inspector and the type of records he must keep in discharging his duties.


This ordinance regulates the emission of smoke from chimneys, stacks, flues, or open spaces within the city of Philadelphia; provides a color scale for the measurement of the degree of darkness of such smoke; makes it unlawful to permit the escape of smoke of a certain degree of darkness; and provides a penalty for the violation of this ordinance.


The ordinance provides for regulating the production or emission of smoke from stack or other source within
the corporate limits of the city of Pittsburgh, except buildings used exclusively for private residence purposes and flats and apartment houses in which there are fewer than six apartments, and prescribing penalties for the violation of the provisions thereof.


This act provides for the abatement of smoke, in cities of 20,000 or more inhabitants. In each such city the emission of smoke of a degree of darkness or density equal to or greater than that of No. 3 of Ringemann's chart from any stack, except stacks of locomotives, for any period or periods in the aggregate 6 minutes in any period of 1 hour, or from any stack of a locomotive for any period or periods in the aggregate exceeding 1 minute in any period of 5 minutes, except as hereinafter provided, is hereby declared to be a public nuisance and is hereby prohibited.


Color scale for smoke detection was adopted. Dark smoke is prohibited, including dark smoke from locomotives and boats. Soot must not be expelled or suffered permitted, or caused to escape from any stack, flue, or chimney.


The emission of dense smoke into the open air within the corporate limits of the city of St. Louis, from the smokestack of any railroad locomotive, steamboat, steam tug, steamroller, steam shovel, steam derrick, steam piledriver, or other similar machine or contrivance, or from the smokestack or chimney of any building or premises whatsoever, except as is hereinafter expressly permitted, shall constitute a public nuisance, and is hereby prohibited.


The emission of dense smoke from the smokestack of any boat or locomotive, or from any chimney, anywhere within the City of St. Paul, is declared to be a nuisance. Any person violating this ordinance shall be punished by a fine of not less than $25 nor more than $100 or by imprisonment of not less than 10 days nor more than 90 days.


The emission of dense smoke within the city from the smokestack of any locomotive, steam boiler, steam derrick, steam piledriver, or other portable or temporary smoke-making device or apparatus, for a period or periods aggregating not to exceed 6 minutes in any 1 hour, during which period or periods the fire-box or boxes are being cleaned or a new fire or fires are being built therein, is declared a nuisance. A penalty shall be imposed on any violator.


In the City of Springfield the emission in the open air of dark smoke or dense gray smoke for more than 2 minutes continuously, or the emission of such smoke during 12 percent of any continuous period of 12 hours is hereby declared a nuisance.


This bylaw attempts to compel the prevention of smoke and provides for a penalty to offenders.

1926


If for no other reason, this paper is conspicuous for the dictum that "efficient smoke prevention should start at the furnace end of the installation, and not at the chimney top."

It is interesting to note that the Calcutta and Howrah Smoke Nuisances Act legislated against smoke as far back as 1863 in India, but that effective action only began with the passage, in 1905, of the Bengal Smoke Nuisances Act, which in the past 20 years has reduced the average emission of dense smoke per chimney from 151 to 1.19 minutes per hour.

Here, as noted by Monnett for America, much—or most—has been done by voluntary effort based on realization that smoke means waste. Much success followed the efforts of the Smoke Commission in India to get the firemen voluntarily to receive instruction and present themselves for examination in stoking.

Later the act was amended so that "no furnace, flue, or chimney should be constructed, altered, or reconstructed unless in accordance with plans previously approved by the State Department" (a Government Department) which specified various area proportions, excellent results followed the adoption of these standards when the department reminded them effective by providing free plans and advice.

Vertical boilers of loco type proved the worst offenders, owing to their chimneys being only 20 percent of the standard size specified supra; when this defect was remedied, they became almost smokeless.

Reference is made to the fitting of a "combustion indicator," working on the percentage of CO₂ in the flue air, requiring no attention, and resulting in great economy associated with smokeless plant. (BH)

1927


After the adoption of an ordinance by the City Council of Cleveland, Ohio, the Department of Smoke Abatement was organized about July 1900. The department has been operating up to the present with varying degrees of success, but always showing improvement in the elimination of smoke from year to year. One particular point has been demonstrated during this time: A continuous never-ending pressure and constantly keeping the subject before the people are the only ways to make smoke-abatement movement successful.

1929


The object of a law is largely to regulate and reduce excesses of various kinds.

The Thermic Syphons that establish and maintain a complete and vigorous circulation of the boiler water are described.

1930


The criminal and civic aspects of smoke ordinances are discussed.

Tentative draft of a standard smoke-abatement ordinance prepared by a joint committee of representatives of interested organizations.

1931


Violations of the smoke ordinance in New York City has been reduced more than 85 percent during the past year through the efforts of the Health Department, according to the head of the trial board for offenders. Although an average of 70 to 80 cases were heard weekly when the smoke abatement work started a year ago, only 5 to 10 cases are now brought to trial each week.

Most offenders did not know that they were making smoke and took corrective steps when apprised of their offense. On the other hand, it has been found difficult to prove to the courts that smoke from chimneys constituted a health menace. In one or two of the cases lost in court, the lawyers' fees for the defense have been far more than the cost of correcting the smoke nuisance.

Lack of education on the harmfulness of smoke is mainly responsible for the nuisance. A survey of the city from tall buildings would show that at present the air is free, except for the smoke coming from power houses and heating plants, since the private owner has brought about more improvements.

1932


The Public Health (Smoke Abatement) Act, 1926, made provision for the combination of neighboring local authorities for smoke control. As smoke has no respect for municipal boundaries, the problem of dealing with it would appear to be essentially one for regional rather than local treatment.

Regional smoke-abatement committees have been formed in several of the larger industrial areas. Most of these are advisory only. The Sheffield, Rotherham, and District Smoke Abatement Committee is the first and only statutory committee of its kind in England. The committee has been in existence only 18 months—a time far too short to warrant any conclusion as to efficiency or value.

The area dealt with covers 123 square miles. From the standpoint of smoke control, it is a particularly difficult area because it is said to contain more metallurgical furnaces than any similar area, located chiefly in valleys where they are protected from the beneficial effect of prevailing winds.

The three principal sources of smoke—boilers, metallurgical furnaces, and the domestic grate—are considered in detail. (BH)

1933


This is a law on which local regulations should be based. It is confined to four articles of which the first reads as follows: Industrial, commercial, or administrative establishments are forbidden to emit either smoke, soot, dust, or toxic or corrosive gases liable to inconvenience the neighborhood, pollute the atmosphere, or to injure the health or the safety of the public, agricultural production, the good preservation of monuments, and the beauty of sites.

Articles 2 and 3 deal with contraventions and penalties and Article 4 lays down that the law will enter into force 1 year after its promulgation as regards establishments owned by the State, the Departments, the Communes and persons holding concessions therefor, and 3 years as regards private industrial establishments. (BH)

1937


The organization of the Industrial Smoke Abatement Association of Hudson County, N. J., and the creation of the Department of Smoke Regulation as a part of the Hudson County Board of Health are described.

This is said to be the only location in the world where smoke abatement has progressed to the point where the majority of the industries have become members of an organization that works with, but independent of, the county department of smoke regulation.


Chicago's efforts to reduce its atmospheric pollution dates as far back as 1881 when the first smoke ordinance was approved.

The scope of the work and the conclusions are cited. As conditions of marketing, transportation, and fuel facilities indicate that the expansion of Greater Chicago into an industrial heart of the country is inevitable, it seems desirable to study the control of sulfur dioxide. Knowledge of the possible harm to health, vegetation, and building materials by the prevailing concentration of sulfur dioxide in a city like Chicago is limited. Present methods of abating sulfur dioxide are criticized as not being satisfactory.


This is a general statement of the organization and work of the Hudson County (N. J.) Department of Smoke Regulation.

Hudson County has a rather strict ordinance relating to smoke abatement, details of which are given. Included in the ordinance are rules and regulations governing the technicalities of installation of fuel-burning equipment. Permits are issued, and installations are inspected after completion. If they comply with the specifications as filed, a certificate to operate the equipment is sent to the owner. A fee is charged for the permit and certificate, the amount depending on the size of the installation.

Reference is made to the assistance rendered by the Railroad Smoke Abatement Association, the Marine Smoke Abatement Association, and the Industrial Smoke Abatement Association.

The average locomotive smoke density decreased each year from 19.5 percent in 1931 to 1.96 percent in 1936.

1936


The details of the Smoke Act (passed by Congress August 15, 1935, and its operation are outlined. The Act is short and concise, but includes all that is necessary in any law and has proved workable.

The District of Columbia smoke law is probably the strictest in the country, with regard to violations. There is no period of grace so that, strictly speaking, any emission of No. 3 Ringelmann smoke, no matter for how brief a period, is a violation.

A permit must be obtained for the installation of all fuel-burning equipment, and all building plans are
LEGAL ASPECTS OF AIR POLLUTION


Section 2: The emission of smoke of a degree of darkness or density equal to No. 2 of the chart or greater, for more than 6 minutes in any 1 hour from stacks of Class I; or of a degree equal to No. 2 of the chart or greater, for more than 6 minutes in any 1 hour, but not exceeding during said 6 minutes a degree equal to No. 3 of the chart or greater for more than 3 minutes, from stacks of Class II; or of a degree equal to No. 2 of the chart or greater, for more than 25 minutes in any 1 hour, but not exceeding during said 25 minutes a degree equal to No. 3 of the chart or greater for more than 5 minutes from stacks of Class III; or of a degree equal to No. 3 of the chart or greater for more than 3 minutes in any 1 hour from stacks of Class IV; for more than 5 minutes in any 1 hour from stacks of Class V; and for more than 20 seconds in any one period of 5 minutes from stacks of Class VI, is hereby prohibited.


A model smoke abatement ordinance adopted by the Smoke Prevention Association.


New clauses on smoke nuisance have been introduced in the Public Health Act, 1936. They lay down that where the emission of smoke to the atmosphere from any chimney or plant is not prevented so far as the industry is practicable a statutory nuisance is committed. Notice of the existence of a nuisance must be served within 24 hours. Reference is made to experience at Stoke-on-Trent, which has long been infamous for its atmospheric pollution. The emission of smoke is largely due to the pottery industry, with the numerous ovens through which pottery has to be passed in course of manufacture. First comes the biscuit oven, wherein the goods are exposed to the highest temperature and most smoke is emitted, next comes the glazier oven where the goods are glazed while enamel kilns are used for enameling goods. Each of these kilns is described, and charts are shown of smoke emission from them. In recent years progress has been made in firing pottery; there are now 21 electric kilns, and 41 gas-fired ovens, with 13 more in course of construction. The electric kilns annually take the place of 8 to 10 thousand tons of coal; and the gas-fired ovens are equal to 47,242 tons of coal per year. The best hopes for future progress is that these modern kilns and ovens turn out better ware and are cheaper to run, but they are expensive to install. Hints are given as to how the emission of smoke may be minimized with ordinary chimneys and flues. (EH)


The smoke ordinance of the city of St. Louis is discussed. As a whole, this ordinance differs very little from similar ones in other communities, contains all the essential features necessary for the control of heating and industrial plants, and requires permits and certificates of operation. However, in addition it includes a washing clause requiring that coal of certain sizes shall not be imported or sold in St. Louis, unless the coal has been cleaned by a process known as washing. Also, a permit is required for the sale of solid fuel. The applicant for such a permit must file with the city a bond for $1,000. Provision is made to revoke permits of those convicted of a violation of the ordinance.


The course of legislation to control air pollution in St. Louis is reviewed for 73 years. In 1864 St. Louis became conscious of its smoke through an altercation that arose between two neighbors. In this case a judgment of $50 was rendered in favor of the plaintiff. The first engineering report on smoke was filed in 1892. History of legislation to eliminate smoke in the last 73 years in St. Louis should prove conclusively to its citizens that legislation will not abate smoke. It also indicates that some of those who condemn the lack of progress most vociferously are the greatest offenders. Therefore, it behooves those in charge of this work to initiate steps that will produce the desired results irrespective of the opposition.

1939


Quotes basic ordinance for smoke abatement prepared by representatives of American Society of Heating and Ventilating Engineers, Stoker Manufacturers Association, American Civic Association, and American Society of Mechanical Engineers; model ordinance developed by Smoke Prevention Association, including summary of answers to questionaire pertaining to smoke ordinance regulations sent to approximately 200 cities in the United States; and rules and regulations of Washington, D. C., regarding fuel-burning equipment. Also discusses human factor in smoke abatement.


The content of the Cincinnati smoke ordinance, method of operation, and some of the salient points of the proposed revision of the Cincinnati Smoke Code are described.

The ordinance must be reasonable, the majority of the people must desire it, and the honest contractor and merchant must support it.


If air-pollution abatement is to make the advances demanded in cities, it appears that ordinances and methods of enforcement need to be scrutinized. Excellent work has been done by smoke-ordinance enforcement officials and their staffs, working under the conditions prescribed by law, in many localities. The demand is for more law enforcement in abating smoke nuisance, and more of this mandatory regulation will be forthcoming in various communities. The responsibility for sound and logical development of regulations rests with those familiar with the difficulties. Some of the results are given of the current survey of Pittsburgh to determine the amount of dirt in the city and its sources. Ordinances and their enforcement in the control of air pollution are discussed.

It is contended that to meet the demands of the public, it is going to be necessary (1), to draft laws that will make possible the measure of air purity it desires; (2) to bring people to a realization that the low-pressure heating plant as used in small commercial establishments, apartments, and private houses is, in proportion, the worst offender; and (3) to secure their cooperation—willingly in most cases, arbitrarily in some.
As any fuel that contains 23 percent or less volatile matter on a dry basis and establishes certain restrictions for the use and distribution of all fuel in the city of St. Louis. (5) It grants to the city power, under certain circumstances to declare an emergency and purchase fuel for distribution through the established channels of trade or otherwise. (6) It specifically states that the roadrails are subject to permit requirements as any other user of fuel in St. Louis. (7) It makes it mandatory for those installing, repairing, or reconstructing any fuel-burning plant to obtain a permit for such work and the approval of the Division of Smoke Regulation before such work is done. (8) It requires the Division of Smoke Regulation to make an inspection upon all work that is being done under a permit of the Division and to issue a certificate stating that the work that has been done meets the approval of the Division. (9) It requires all those using fuel-burning equipment to report their sales to the Division of Smoke Regulation in writing after such sale has been made. This provision does not apply to wholesale transactions made for the purpose of resale. (10) It prevents the Building Commissioner from issuing a building permit for any structure wherein the plans show a chimney or smokestack, unless such chimney or smokestack has been approved by the Division of Smoke Regulation. (11) It enables the Commissioner of Smoke Regulation to issue a permit for any new fuel-burning installation, unless it is equipped with mechanical fuel-burning devices or uses a fuel containing 25 percent or less volatile matter. (12) It publishes fees for the issuance of permits and certificates ranging from $1.50 to $5.00. (13) It grants the right to appeal from any decision of the Commissioner of Smoke Regulation within 10 days from such decision. (14) It authorizes the Commissioner of Smoke Regulation to establish any fuel-burning penalties for violations of the law. (15) If any violations of the law are recorded in any 12 consecutive months. Before such sealing, however, a hearing must be held in order that the violator may have an opportunity to show cause why such action should not be taken. (16) It prohibits interference with the inspectors of Smoke Regulation in the performance of their duties at all reasonable hours and states that such interference is a misdemeanor under the terms of the ordinance. (18) Finally, the ordinance definitely establishes the fact that all high-volatile fuel must be burned in mechanical fuel-burning equipment, and if one desires to hand fire his furnace he must use a fuel containing less than 23 percent volatile matter. 1941


More than 125 representatives of 55 member clubs, which form the Federated Civic Association, met April 10 to hear Cincinnati's smoke-abatement problem discussed pro and con. After the subject had undergone a rather drastic examination and had brought out copious and lucid definitions of the problem, no acceptable solution was forthcoming. It was decided to refer back to the committee, for further study, a resolution on which the delegates were unable to agree, its terms involving a choice between the so-called St. Louis plan and the Cincinnati plan of city ordinances intended to abate smoke. The resolution suggested "the prohibition of burning of certain fuel that cannot be burned efficiently in unsuited equipment."
Delegates were unable to decide whether factories or small homes caused the most trouble or whether Cincinnati needed smoke elimination or merely smoke abatement. There were conflicting statements as to whether it would be feasible for Cincinnati to get enough high-grade coal to achieve smoke elimination and whether greater heat and cleanliness would compensate for the extra cost of higher-grade fuels.


Under ideal conditions, proper firing methods, satisfactory atmospheric conditions, and proper boiler settings, semibituminous or low-volatile coal and bituminous or high-volatile coal may generate smoke. Anthracites are excluded from the discussion as their chemical composition makes them inherently smokeless.

The fact that abnormal conditions of firing far outweigh the normal forms the major problem of the smoke-inspection departments of our larger cities.

Unfortunately, some cities have endeavored to meet this situation by enactment of, or efforts to enact, smoke ordinances based alone on the volatile content of the coal, regardless of the chemical composition. A smoke ordinance that will provide for smoke nuisances, regardless of volatile content, is advocated, as volatile content alone does not measure smoke density. Tests as described that show smoke-producing density is not measured by volatile content.

**1942**

**3681. COAL AGE. Smoke Elimination Law Upheld by Missouri Supreme Court. Vol. 46, 1942, p. 86.**

On August 6, 1942, the Missouri Supreme Court upheld the St. Louis smoke-elimination ordinance. Denying a writ of habeas corpus for a defendant convicted of violation of the law, the court found that the ordinance is within the police power and that the validity of the rule and the provisions of the ordinance are reasonable.

**1945**

**3682. BRITISH DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. Smoke Abatement in the City (of London). Fuel Abs., vol. 2, 1945, Abs. 4330.**

At a meeting of the Common Council it was resolved to seek Parliamentary powers to require that plans and specifications for heating arrangements in new buildings, whether for the generation of power, the warming of rooms, the heating of water, or the cooking of food, should be submitted to the Corporation for approval and also, to seek power to declare any area of the city a smokeless zone in which the emission of visible smoke from any chimney should be an offense.

**3683. COAL AGE. Allegheny Moves To End Smoke Fall. Vol. 50, 1945, p. 188.**

Commissioners of Allegheny County, Pa., moved November 23 to draft an antisoot rule patterned after that of Pittsburgh and designed to reduce the smoke from steel mills, homes, and business establishments. The commissioners ordered the County Law Department to draft a tentative antisoot law, under provisions provided by the legislature of 1943. Pittsburgh's ordinance, passed in 1941, contains basic provisions that have been postponed because of the war. Smoke-control advocates insist that antisoot laws to be effective must cover the entire county, as "smoke doesn't recognize municipal boundary lines." According to Pittsburgh Health Department statistics, there is an average of only 87 clear days in the Allegheny County area.


Three smoke ordinances involved in the smoke abatement program in St. Louis (Mo.) are reviewed. The system of permits for fuel burning installations and certificates of operation determine the characteristics of the plant while the licensing of fuel dealers governs the type and character of fuel used. Methods of enforcing these laws are described. (FA) 1946


The present position in relation to the laws concerning smoke abatement is discussed. Hints are given on how to avoid the waste of fuel in smoke, and a more considered approach to the problem of smoke prevention is advocated. (FA)

**3686. COAL AGE. Smoke Ordinance Passed in Columbus. Vol. 51, 1946, p. 152.**

An ordinance designed to reduce the smoke nuisance to a minimum and providing fines ranging from $10 to $200 for violators was approved in Columbus, Ohio, April 30, effective in 30 days. The ordinance was drafted by a special smoke-abatement committee and calls for annual inspections of all fuel-burning equipment except that in private homes and locomotives. Two 5-man boards are created, one to advise the chief smoke inspector and the other to hear appeals from decisions of the engineer. (FA)

**3687. COAL-HEAT. Tichten Chicago Smoke Ordinance. Vol. 47, 1946, p. 81.**

The City Council of the city of Chicago recently changed section 90-71 of the Municipal Code of Chicago, which is amended to read as follows: 90-71. Emission of dense smoke. It shall be unlawful for any person owning or in charge of any smoke stack of any locomotive, tar kettle, steam machine or contrivance, or of any open fire, smoke stack or chimney of any building or premises to allow the emission of dense smoke, except for a period of or period aggregating 6 minutes in any 1 hour at the time when the firebox is being cleaned out or a new fire being built therein, during which period of or periods aggregating 6 minutes in any 1 hour, the emission of smoke of a shade or density greater than No. 3 of the Ringelmann Chart as published by the United States Bureau of Mines, is prohibited. Such emission of smoke is hereby declared to be a nuisance, and may be summarily abated by the Deputy Smoke Inspector in Charge, or by anyone who may duly authorize for such purpose. Such abatement may be in addition to the fine hereinafter provided. (FA)

**3688. COLLIERY GUARDIAN. Smoke Control. Vol. 172, 1946, p. 125.**

New methods for smoke reduction and prevention in towns are detailed in a booklet recently prepared for local government authorities. It is necessary that plans and specifications of all new fuel-burning plants be approved by competent authority before installation, and it is suggested that plans for new or reconstructed heat-producing plant be filed with the local authority.


With a view to obtaining a more constructive type of legislation the National Smoke Abatement Society is putting forward for discussion preliminary proposals for extensions of the Public Health Acts by means of which local authorities could obtain by-laws that will help to prevent smoke and will directly encourage fuel efficiency and coal conservation. Three sets of by-laws are proposed. The first would require all proposed fuel-burning installations (other than domestic) to receive the prior approval of the local authority before installation and operation. This is analogous to the
present building bylaws. It would not prescribe what fuels or specifications should be used but would be concerned only with approving the plans and specifications of the applicant. The second section of bylaws is concerned with ensuring that existing fuel-burning plant shall be maintained in good working condition, shall not be overfired, and that smoke or grit shall not cause smoke or grit nuisance, and that surfaces and flues shall be "cleaned as often as may be necessary to ensure the efficient working of the plant to prevent smoke nuisance." The third section of bylaws concerns the certification of plant to prevent smoke nuisance and the certification of stokers and furnace men. Certificates would specify the class of plant the holder was qualified to operate and would be necessary for men operating installations included in a special register kept by the local authority. The certificates would be issued on evidence of experience and competence or provisionally. They would not, for the present, be dependent on any tests, examinations, or attendance at training courses. It is considered that by this means the status and rewards of the stoker will be raised and that the work will become recognized as skilled and responsible.

The society is seeking the views of local authorities, fuel traders, industry, and makes its proposals more definite, and will consider any suggestions for amendment, or criticisms, at its annual conference at Brighton in October. (FA)


Certain factors are discussed pertaining to the installation of a stoker with reference to their effect on the smokeless operation of the equipment, including setting heights, furnace volume, ash storage, and accessibility for cleaning of fires, flues, and box. In dealing with the smokeless operation of stoker-fired plants the importance of proper adjustment of air and coal feed, regular attention to cleaning of fires, flues, and wind box cleanouts, and the provision of adequate firing tables are stressed. Reasons are given for recommending that no technical rules and regulations be published in the city ordinance but that they be provided in one of the following ways: (a) Adopting, by reference in the ordinance, the standards and recommended practices of the individual industry, such as those published by the Stoker Manufacturers Association. (b) Providing, in the ordinance, that the Chief Smoke Inspector be vested with the authority to initiate, add to, delete from, and revise the technical rules and regulations governing installation of fuel-burning equipment; that the rules and regulations so adopted differentiate between single retort underfeed stokers up to 1,200-ounces-per-hour capacity and the larger stokers of industrial or power sizes. (APB)


The Minister of Fuel and Power was asked if he had considered the recommendation of the Fuel and Power Advisory Council that legislation should be passed to enable smokeless zones to be established and that a few such zones should, for experimental purposes, be declared, and if legislation will be introduced. The reply was that the recommendation had been considered. It is not proposed to take steps to introduce general legislation in this matter at the present time; one local authority already has powers under which it can establish a smokeless zone. (APB)


An ordinance regulating the production and emission of smoke from any chimney, smokestack, or other source within the corporate limits of the city of Pittsburgh; regulating air pollution caused by the escape of soot, cinders, noxious acids, fumes, gases, and fly ash with in the city; regulating the importation, sale, use, and consumption of certain fuels; regulating the construction, reconstruction, repair, maintenance, use of, and additions to, refuse-burning equipment and fuel-burning plants, including fuel-burning equipment and devices, and requiring notice to the city of all purchase and sales thereof, establishing a Bureau of Smoke Prevention; requiring smoke indicators or other approved methods of observing smoke from the boiler or furnace room in certain cases; establishing fees for examination of plans and issuance of permits, inspection of furnaces or other fuel-burning equipment or devices, and issuance of certificates of operation; establishing an Appeal Board, and providing fines and penalties for the violation of the provisions of this ordinance.


The City of London Act.—The purpose of the act is "to make temporary provision with respect to ward elections in war-damaged wards in the city of London and for other purposes." In Part III, Miscellaneous, section 14 (1) the power to make bylaws under section 151 of the Public Health (London) Act, 1936, is extended to "include power to make bylaws for the case of new buildings and in the case of substantial alterations in the arrangements for heating in any existing building the provision to the satisfaction of the Corporation of such arrangements for heating as are calculated to prevent the emission of any small amount of smoke." The second part of section 14 is a safeguard to allow the owner or occupier of any building to use whatever type of smokeless fuel may in his discretion select and to prevent the Common Council of the city from imposing conditions as to the use of any particular type of smokeless fuel. The new bylaws permitted under this act are limited to "arrangements for the heating of buildings." The Manchester Act.—Part VI is concerned with nuisances and sanitary matters and begins, under section 35 (1), with a definition of the city's central area. It is that area bounded by St. Mary's Gate, Market Street, Piccadilly, Portland Street, Oxford Street, Peter Street, and Deansgate. Subsection 35 (2) declares "As from the commencement of this section no smoke shall be emitted from any premises in the central area." Subsection (35) (3) lays down that the penalty for smoke emission shall not exceed £10 and a daily penalty for continuing of not more than £5. Subsection (4) (a) provides that the smokeless zone as defined may be extended and applied to any area or areas within the city under an order made by the corporation and confirmed by the Minister of Health. The first subsection of section 36 states "No person shall install in any building whether erected before or after the passing of this act any furnace for steam raising or for any manufacturing or trade purposes, unless such furnace is so far as practicable of being operated continuously without emitting smoke." (FA)

1947


After a century of agitation a city ordinance, effective October 1, solemnly banned the city's smog. Pittsburgh's official bid for blue skies follows similar moves by St. Louis and Cincinnati. Ironically, the steel city's introduction to the new law last week was subdued by a thick natural fog. It was the same on the two following days.
But the gradual achievement of blue skies will be speeded when surrounding Allegheny County invokes a code that backs up the city ordinance.

The new code requires that within city limits only smokeless fuels may be burned—except where stokers are used to control the gas and soot thrown off by high-volatile coal. Dealers are now prohibited from delivering high-volatile bituminous to homes, apartments, and other buildings that are not equipped for smokeless combustion. Big buildings, railroads, industries had already come under the ordinance. Chimneys of the city's 150,000 dwelling houses were last to be affected. Dwellings in eruption of smoke regulations in St. Louis and Cincinnati are cited.


After 107 years of combined efforts, citizens have succeeded in their attempts to launch a drive toward making the world's steel center a clean city, with the inauguration of full-scale smoke control. Pittsburgh's poll, which as early as 1840 caused local newspapers to carry complaints about "sulfurous vapors" that filled the air and made the day "like the winter," a combination of smoke and fog, usually starts with the beginning of chilly weather in September and continues into spring. Thirteen smoke inspectors have been assigned to watch the 75-square-mile area. The City Bureau of Smoke Prevention intends to be lenient at first; it has ruled that any type of fuel may be burned as long as it does not cause emission of smoke. (FA)


Several opinions are given of the requirements of an air-pollution ordinance. (FA)


In an effort to find out what should or should not go into a smoke or air pollution ordinance a number of leading smoke inspectors in the United States were asked to give their opinions, which are recorded in this paper. (FA)


This survey discloses basic facts on the numerous sources of air pollution in and around Philadelphia, and the report makes statements, observations, and recommendations with respect to necessary preliminary steps toward initiating an air-pollution-control program. In the appendix a suggested draft of a model air-pollution-control ordinance is included. (APB)


A survey of 296 plants is reported, and an analysis is made of the factors contributing to atmospheric pollution, such as velocity and direction, topography, industrial diversification, fuel characteristics and consumption, heating characteristics, etc. Recommendations are made for the most effective legislative approach to the solution of Detroit's air-pollution problem. (APB)


Points out the futility of passing laws against the burning of high-volatile coal; instead, the effort should be devoted to smokeless combustion of fuels. (APB)


The legislation here published includes a City Charter amendment, the Air-Pollution-Control Ordinance, and the Rules and Regulations of the Air-Pollution-Control Board. Permits are required for both installation and operation of all burning devices, with inspection before the final permit. Smoke is regulated according to Ringelmann charts, and fly ash is limited to 6.5 pounds per 1,000 pounds of fuel oil, with total output limited to 15 percent of the total dust. Height of stacks, oil burning, discharges into sewers, smoke from locomotives are regulated. Secret processes are protected by requiring disclosure of only the combustion part of the process when the affidavit describes the process as secret. (FA)


Section 35 of the act, which relates to the prohibition of smoke in certain areas, is not yet in force, but Section 36, which prohibits the installation of any furnace for steam raising or for any manufacturing or trade purpose, which does not comply with the provisions of the Section, came into effect on the commencement of the act. (APB)


As indicated by the titles, arguments are given for the opposing points of view. (APB)


Effects on health and vegetation and economic loss resulting from uncontrolled smoke are cited. Such pollution of the atmosphere is a preventable evil.

Smoke ordinances of several cities of Connecticut are cited. These cities have been successful in reducing air pollution by carefully prepared ordinances administered in an understanding manner, so as to preserve the rights of both fuel consumer and general public.

3705. Los Angeles Office of Air Pollution Control, Rules and Regulations of the Air-Pollution-Control District. 1947, 4 pp. (FA)


The Fuel and Power Advisory Council of the Ministry of Fuel and Power issued its report on Domestic Fuel Policy early in the year. One of the terms of reference of the Council was to consider the abatement of smoke from household fires, and in its recommendations this factor is integrated into the general policy in an entirely satisfactory way. Preceding this important report was the more technical report Heating and Ventilation of Dwellings of the Committee of the Building Research Board, which also stressed the importance of smoke prevention and included an informative appendix on atmospheric pollution. To set up smokeless zones, not only in the center but in other parts of the city, and to require the prior approval of all new steam-raising and other industrial or trade installations are important sections of the Manchester (General Powers) Act, 1946, and powers to make bylaws for the prior approval of new installations are included in the City of London Act, 1946. An interesting development in planning for smokelessness is the setting up in Britain of a coordinating Smoke Prevention Committee of all the interested Committees of the City Council. In Sheffield the Society's suggestion in smoke control has been acted upon by including a smoke-control clause in all leases of Corporation-owned land to be used for industrial purposes. (APB)
AIR POLLUTION—A BIBLIOGRAPHY


The health commissioner has announced that he will lead a campaign for better enforcement of antismoke laws in New York City. He asks for $100,000 for preliminary plans and additional personnel to begin the smoke-abatement program. It is considered that if smoke costs the nation an average of perhaps $20 per person annually, as the United States Public Health Service once estimated, New York could as a city of nearly 8 million afford to pay $150 million a year if it would rid the city of smoke. (APB)


The various court decisions involving the validity of those smoke-control ordinances that have been tested in the courts are summarized, and a model ordinance is presented. It is suggested that the model ordinance be adapted to the needs of each city that uses the model in drafting an ordinance to meet its own needs. This model offers the best ideas contained in ordinances already adopted by cities and recommendations by experts on the subject of air pollution and also deflects the legal rules enunciated by the court decisions in this field. It is hoped that this report and the model ordinance will serve their primary purpose of aiding the city attorneys in solving the legal phases of the air-pollution problems of their cities.


An effective antismoke program was found necessary in Salt Lake City. A law was passed to prevent evasion of the issue. All phases of fuel burning are covered by the law. A patrol system was instituted to notify of violators. Combustion equipment and its installation must be approved by city officials. Operators' licenses are issued subject to revocation. Ordinance specifies installation conditions of fuel-burning equipment. The program was relaxed during the war. Results of campaign are reported to be gratifying to city commissioners and citizens generally. (FA)

1948


The progress of smoke control is described; existing ordinances in 46 cities are summarized, by cities; the officials in charge of smoke control are listed; and a check list of ordinance provisions is provided. (APB)


Deals with the emission of grit and sulfur gases from new electricity power stations. (FA)


Smog regulation has been a concern of Los Angeles for a number of years, and the past decade has seen increasing cooperation of scientists, industrialists, and city officials in solving the problem. In 1947, the Los Angeles County Air Pollution Control District was established by law to enforce corrective measures. At the time the scientists were called in, it was realized that strict enforcement of regulatory measures might be difficult, because: (1) Specific causes of smog were largely undetermined; (2) standard methods of sampling and analysis had not been developed; (3) suggested corrective measures were often unsound; and (4) without a scientific background, public reform pressure would lead to unfair and ineffective courses. In the present program, oral scientific and engineering advice is offered free to enforcement officials and industrialists. The consulting committees have consistently recommended a policy of sound basic research and engineering advice, full cooperation to help industries help itself, and avoiding what would overtax that gives only half solutions. The plan of organization is explained and shown in a diagram. The main features are the Atmospheric Purification Committee, a Scientific Committee, a Process Consulting Group, committees within the industries, and a Joint Laboratory Research Group. The plan of handling suspected cases of smog production by members of a particular industry by the various groups in cooperation enables maximum results to be obtained with a minimum of friction, time, effort, and money. (APB)


At a meeting of the Bradford and District Chamber of Trade, the secretary of the Bradford and District Coal Merchants' Association, sought support against the smoke-abatement clause in the Bradford Corporation bill, which if enforced, would involve traders in the center of Bradford in great expense. He stated that as he understood it from press announcements on the bill the whole central area was to be smokeless. This would mean that traders would be called upon either to alter the present plant or install a new plant to take smokeless fuel. The Bradford Property Owners' Association and the Bradford Chamber of Trade had already promised support. (APB)


Bradford Chamber of Commerce has decided to raise no objection to the inclusion by Bradford Corp. of a smoke-abatement clause in the Bradford Parliamentary bill. (APB)


A popular article on air pollution.

Given the right weather conditions, enough poisonous fumes are poured into the air every day to produce a great disaster. Great Britain, Belgium, and Sweden may have stringent national air-pollution-control legislation.

Discusses results of the survey made in 1932–33 by the United States Public Health Service.


There has been no relaxation of the standard condition that the layout of new power stations shall be designed to permit installation of a plant to prevent the discharge of sulfur and its compounds into the atmosphere; and that, if so required by the Electricity Commissioners at any time, a plant shall be installed for this purpose. The observance of the latter part of this condition has not so far been required by the commissioners at any new coal-burning power stations since the war, as they have not received evidence to justify such a course. (APB)


Stringent regulations are in force in Los Angeles regarding the amount of hydrogen sulfide and sulfur dioxide that may be emitted into the atmosphere from any plant operation, and several refineries that have previously burnt their waste gases containing a substantial amount of H2S are compelled to take steps to abolish this nuisance. They are now scrubbing out the H2S by various methods and selling stripped hydro-
gen sulfide gas to the Hancock Chemical Co., who will convert it into sulfur in a Simon-Carves sulfur-recovery plant. Fifty tons per day of this gas, which was formerly vented to the atmosphere, will now be made into pure sulfur. (APB)


Niagara Falls is the first city in the United States to adopt an ordinance providing complete coverage for all types of atmospheric pollution—dusts, gases, fumes, mists, vapors, smoke, and odors. The ordinance is also unique in setting up an air-pollution-control board to keep rules flexible.


Local authorities were urged to appoint an officer to give all or part of his time specifically to the question of smoke prevention. (APB)


It is recommended that all new fuel-burning plants, other than domestic appliances, should be approved by the local authority before being installed or operated. (APB)


Air-pollution-control problems and their control in New York are considered. Since 1903 the city has had a sanitary code prohibiting discharge of annoying emanations of smoke, cinder, gas, steam, and offensive odors. In 1937 a building code was adopted, which included the requirement that plans and specifications for fuel-burning installations must be filed with the commissioner of Housing and Building before installation. It was also stipulated that fuel equipment should be designed not to discharge smoke, soot, cinders, or fly ash in such quantities as to cause annoyance to the public or injury to business property.

The Health Department has estimated that the Smoke Unit initiated over $2,000,000 worth of plant modernization and improvement during the past year; and $3,500,000 worth in the year to come.


The new Salford Corporation Act makes it illegal to any part of the post-war housing supply, and the tenants will have to use gas, electricity, coke, or other smokeless fuel for all purposes.


The former smoke commissioner of St. Louis, which is famous for its ordinance prohibiting the burning of high-volatile coal in hand-fired heating and other plants, summarizes nine different points that have been made to the discredit of the St. Louis smoke ordinance and answers each in some detail. (FA)

1949


Cupola operation is so spectacular and noticeable that foundries are the first to be blamed for atmospheric pollution in their neighborhood, whereas other industries, weather, and topography may have much greater actual effects. Through surveys before enacting legislation are expensive, but legislation prepared without knowledge of actual conditions and proper standards may be hostile to the foundry industry and others. Several examples of such legislation are cited. Suggestions are given for dust and fume reduction. Foundries should be represented in any committee to take action in suppressing air pollution. (HID)


New York has followed the lead of other cities and enacted an ordinance to control the pollution of the atmosphere by industries, heating plants, and other sources. The law has been in effect since February 29, 1949, and provides adequate penalties for those violating its smoke-control provisions. (FA)


The requirements for smoke emission of the ASME Code are presented and compared with those of a number of cities. Apparently it is felt that the ASME Code is too strict to obtain full compliance but rather is "something we are striving to attain."


The Chicago 1907 smoke ordinance requiring that permits be issued for all new steam plants and for reconstruction of old ones and the amended ordinance of 1938 requiring annual inspection of fuel-burning equipment are discussed. These ordinances have been found to be essential to the successful enforcement of the smoke ordinance.


The ordinance provision of the supervision of the installation and annual inspection of fuel-burning equipment in Chicago is discussed. (APB)


In consideration of "the major public interest involved" and an assurance that the respondents will undertake "with all possible expedition" remedial alterations to their aluminum plant at Fort William, Lord Bledisloe postponed pronouncement of a decree of interdict, although finding for the petitioners. The complaint was that fluorine-laden fumes mixed with a tarry vapor were damaging cattle, trees; and other property. (FA)


Discusses the Bradford Corporation Act, 1910, and the Public Health Acts, 1923 to 1936, and summarizes the results of investigations into the causes of smoke in 449 cases of excessive smoke emission from various boiler installations. Seventeen percent of the cases were due to lack of enough draft-producing apparatus to meet fluctuating or peak-load conditions; in the other 84 percent, the excess smoke was mainly caused by careless or faulty operation and negligent maintenance of some part of the boiler plant. The excess smoke that could be attributed to mechanical stoking was due primarily to the human element, in neglecting to adjust or regulate the throw of the stoker shovels to suit the size or condition of the coal in use (and occasional neglect to maintain the propelling parts
for the moving firegrates in good order, so as to secure the full travel of the bars. The greatest single cause of excessive smoke was that due to the spread firing of coal on hand-fired furnace grates. (FA)


This suggested ordinance is based on the smoke ordinance compiled by the Model Smoke Law Committee of the American Society of Mechanical Engineers. It is prepared to include the necessary provisions of a workable ordinance. (APB)


A note on the experiences of Pittsburgh in implementing its policy of smoke abatement by legal enactment. (FA)


Comments are made on the annual inspection requirement for the Model Smoke Law. The Cincinnati annual inspection is said to be an important cog in a complete pollution control program. Details and results of the program are given.


Describes recommended procedures designed to meet California's new law regarding atmospheric pollution, without use of collection systems. (APB)


Although there is no federal statute on control of air pollution, three proposals were pending before Congress that indicate federal interest in the problem. State legislation on the subject consists almost exclusively of statutes that forbid, and authorize counties, municipalities, or health authorities to regulate, prevent, and remove any activities (a) that endanger, injure, or annoy the comfort, health, repose, or safety of the public; or (b) the emission of one or specified types of air pollution. Some of the ordinances and regulations are discussed in some detail. (40 refs. cited)


Some of the problems of organization and cost connected with the creation of a department of smoke regulation are discussed.


As a result of the comparative examination of present-day laws relating to atmospheric pollution, it is found that legal regulation of the disturbance of pollutants into the atmosphere is now more or less in effect in most industrial communities in the United States. Dense smoke is prohibited, and the trend is toward tighter prohibitions against emissions of fly ash, metal, and other fumes, and noxious gases, including particularly sulfur dioxide. Pollutants other than smoke are being specifically prohibited above specified amounts and concentrations, and regulatory powers more positive than common-law nuisance or public-health actions are being given to regulatory officers. Control is effected by inspection and sampling of discharges; by permits to operate existing equipment; by permits to build or install new equipment from which air pollutants may be discharged; and by control of the kind and quality of fuel used. Because of naturally variable conditions no ideal regulatory law is proposed. Especially rigid requirements have been set up in industrial areas where atmospheric temperature inversions result in accumulations of air pollutants that otherwise would be rendered harmless by atmospheric diffusion. The new California statute and the Los Angeles County District rules are illustrative of the trend to restore the atmosphere to its natural purity for the general welfare. (8 refs. cited) (Author's summary)


The Minister of Health was asked if he was satisfied that the Act of 1936 provided adequate powers to deal with smoke nuisance. If he was aware, for example, that some 349 tons of solid matter per square mile per year, that is, 19.1 cwt. per day, fell on Birmingham, and if, in view of the inconvenience and deleterious effects on the health of the residents, especially those who suffered from respiratory ailments caused by fumes from metallurgical processes and excessive smoke from factories premises, he would consider granting powers to the corporation to deal with constant offenders by way of increased penalties. He replied that at the moment, it was not intended to review the law on these matters. (APB)


The necessity for setting up Appeals Boards under the Smoke Ordinance is discussed. (APBB)


Steps taken to reduce air contaminants at the source must be supported by regulatory laws, as attempts to secure results through voluntary corrective action or poorly conceived legislation are of no avail.

Methods for setting up standards for control are discussed. It is suggested that a nuisance statute requiring that no air contaminants be discharged that may cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public or that may cause injury or damage to business or property is of great value in abating some of the air-pollution problems.

Engineering measures leading to actual control of sources of pollution are described briefly.

3743. LONDON TIMES. Control of Unhealthy Gases. 1949; Fuel Abs., vol. 6, 1949, abbr. 15.

The Ministry of Health announced a public inquiry into the detail of a draft order prepared by the Minister extending the types of works and the list of noxious or offensive gases which, under a Works Regulation Act of 1906, may be brought under control in the interests of public health. (FA)


Owing to the adoption of a countywide smoke ordinance in Allegheny County, of which Pittsburgh is a part, intensified efforts are being made to reduce the evolution of smoke and dust. Of the 26 blast furnaces in the county outside Pittsburgh, 14 furnaces will be equipped within about 1 year to clean all of the gas produced, and the other 12 have some degree of gas cleaning. Most of the latter will have to be replaced or rebuilt, so 10 years has been given to bring these installations into complete compliance. New or rebuilt furnaces must not emit fly ash in the gases to exceed 0.50 pound per 1,000 pounds of gas, and at least 80 percent removal of the total fly ash is required.
problem of the dusty gas evolved when the blast furnace burden "slips," owing to carbon accumulation or variations in the charge cannot be solved at present, and gases from open-hearth and Bessemer furnaces are also difficult to clean by present means, although research is being carried out. (CA)


The following questions are discussed in detail: (1) Should the rules and regulations be enacted in the Smoke Ordinance? (2) Is the Chief Smoke Regulation Engineer qualified to prepare the rules and regulations? (3) The need for outside assistance and standard rules and regulations? (4) What is wrong with Section 4 as now written?

3746. Smokeless Air (Spring). Rochdale's Smokeless Zone Planned for 1933, 1949, pp. 36-37.

The Rochdale Corporation Act, 1948, gave the corporation power to prohibit the emission of smoke from the central area of the borough, and, by extension, any other area or areas. The provisions will be brought into force, with respect to the central area, by 1933. This area covers 67¼ acres, and contains 323 different premises, mainly nonresidential. It is probable that new housing areas of the "neighborhood" type (which will now be fitted with appliances suitable for smokeless fuels) will before long be automatically declared to be smokeless zones and that extensions may also be made to the initial zone. (APB)


A paper presented at a sessional meeting of the Royal Sanitary Institute at Nottingham in July 1949 recommends legislation providing for smokeless zones and for the control of fuel and fuel-burning industrial plant, and supports the policy advocated by the Fuel and Power Advisory Council with regard to domestic smoke abatement. (FA)


Smoke control is one of the cardinal objectives in the community-development program for Pittsburgh and Allegheny County. Remarkable results have been produced in the city's atmosphere since the smoke-control ordinances became fully effective October 1, 1947. The ordinance was passed in 1941, but its enforcement was postponed because of the war. In 1946 industry and railroads were brought under control and a year later the households were included. In the 1947 session of the State legislature the county commissioners were empowered to regulate smoke from all sources in the county, including railroad locomotives. The procedure in drawing up the ordinances for Allegheny County is described, and the work of the various industries, organizations, and counties that cooperated in the work is discussed. The ordinance so empowered the county to "abate a nuisance" or to "control air pollution" only indirectly, but it is hoped that the State legislature can be prevailed upon to amend the act to call for the control of air pollution rather than for abatement of smoke.


Quotes basic ordinance for smoke abatement prepared by representatives of American Society of Heating and Ventilating Engineers, the Stoker Manufacturers Association, the American Civic Association, and the American Society of Mechanical Engineers; model ordinance developed by Smoke Prevention Association; and rules and regulations of Washington, D. C., regarding fuel-burning equipment. (IHD)


Summarizes restrictions on the sizing of fuel-burning equipment imposed by smoke-abatement ordinances of 20 cities and counties, including Toronto, Canada.


This reports a panel discussion by the member representing plant engineers in charge of power equipment. One of the questions discussed was whether a group of people in the United States is interested in establishing a Federal or National air-pollution law. One of the members of the panel stated he believed that when the minutes of the United States Technical Conference on Air Pollution were released it would be found that it was recommended specifically at the Washington meeting that any air-pollution legislation should be more or less of a local nature. It was suggested that those engaged in smoke enforcement that they make laws and enforce them but leave it up to management and citizens to spend their money.

The technical and human elements in smoke abatement were discussed. The statement was made that a poorly designed plant properly operated will not smoke. This aroused the question, "Which is the most nuisance, an unapproved plant properly operated, or an approved plant improperly operated?"


This report is concerned primarily with means to reduce air pollution by contaminants other than smoke. Regulation of air pollution appears to present no serious legal problems of a constitutional nature, but the practical problems, particularly those in writing and administering a regulatory law, are not solved easily. Illinois is among the comparatively few States that have enacted laws dealing with air pollution generally, as distinguished from pollution almost exclusively by smoke. Moreover, the Illinois law did not merely to authorize municipalities to act on the air-pollution problem. The air-pollution nuisance is defined in statute.

A number of Illinois municipalities have chosen to act under statutory authorizations by adoption of ordinances designed to control atmospheric pollution. These ordinances may be divided generally into two classes. The first class comprises comprehensive enactments intended to prevent creation of dense smoke and perhaps similar manifestations of other contaminants (for example, the Chicago and Peoria ordinances). The other class is composed of punitive enactments, which in relatively brief form define what constitutes a smoke nuisance in largely specific language: the Champaign enactment is an example of such an ordinance.


New Jersey has established a commission to study air pollution in the State. The commission consists of 12 members, two of whom are professional engineers representing the Senate, General Assembly, industry, labor, and public. It is the duty of the commission to study all phases of air pollution and draft such proposed legislation as is considered necessary. The commission will report to the next Legislature. (IHD)
3754. **Industrial Hygiene Newsletter. Air Pollution, Vol. 10, 1950, p. 10.**

The Industrial Hygiene Section has an additional function in that it provides guidance and direction to the authorities who have the responsibility of controlling air pollution. This program is to be carried out under the provisions of the Air Pollution Control Ordinance in the city of St. Louis. The Smoke Regulation Division of the Department of Public Safety is responsible for the control of air pollution resulting from the burning of fuel or refuse.

The type of air pollution that is particularly the problem of the Industrial Hygiene Section is that from sources other than the burning of fuel or refuse. The Health Division has, in the past, conducted considerable educational work in air-pollution control of this type, even before the passage of this ordinance. However, the ordinance does place responsibility and gives ordinance support for enforcement activities.

3755. **Modern Sanitation, Special Smoke-Control Week**


November 12-18 was set aside as "Smoke Control Week" in New York as a follow-up to National Smoke Abatement Week, which began October 22 under the slogan "Stop all air pollution." Representatives of 25 civic groups decided upon that period at a meeting called by the director of the Bureau of Smoke Control to discuss ways of acquainting the public with this new smoke-control rules and regulations, which went into effect on October 1.

The campaign stressed the "necessity of smoke control from an economical, health and safety point of view by means of talks, movies, store window displays, newspaper releases and posters." The talks were delivered in "layman's language" to assure that everyone responsible for dwellings and establishments that emit smoke had a thorough knowledge of all the rules in question.


The legal aspects of the aerial-pollution problem are discussed from the standpoint of the technologist. Various aspects of the law of nuisance are defined. The severity of the offenders' penalty is usually a difficult determination. Most municipal ordinances resemble the New York Civil Practice Law and Rules. One aim of existing legislation is to prohibit atmospheric pollution where it would be difficult to obtain relief from the courts. For example, where many plants in an industrial area contribute a relatively small amount of contamination, a nuisance may not exist, and yet the aggregate may be very serious.


Good legislation will neither control air pollution nor abate smoke unless it is supplemented by a will to use that legislation and work on the part of those charged with executive responsibility. Those who work with these problems day in and day out have a tendency to think that others feel as strongly on the subject as we do. We forget that to the mayor, governor, or commissioner it is only one of the many and varying problems and a demand on the budget. If adequate delegations of irate citizens protest, air-pollution-control legislation may be enacted. However, immediately after the passage and signing of air-pollution-control legislation, everyone who fought for its enactment breathes a sigh of relief and relaxes. But they cannot afford to relax too long, or their good new law will not be enforced. The obvious things that can happen to circumvent enforcement include failure to appropriate funds, appropriation of inadequate funds, failure to appoint members and director, failure to implement the law with administrative rules and regulations required to be adopted, and failure to provide laboratory facilities and technical staff.


The smoke program in St. Louis had its inception in 1323. A new regulation was ironed at this time and it was believed that the smoke problem was similar to the clarification of domestic water and that all fuel as well as equipment had to be controlled at the source. In the case of water pollution.

The ordinance passed in 1937 contained a coal-washing clause. This gave control of the fuel at the source. A second ordinance empowered the commissioner to license all fuel dealers and require them to furnish a $1,000 surety bond before such licenses could be issued.

Other details of the Smoke Ordinance are discussed. However, the ordinance requires the preparation of all high-volatile fuel for use in mechanical fuel-burning equipment and the requirement that fuel or hard-fired equipment shall use a smokeless fuel strikes at the heart of the problem. These are the provisions that enabled St. Louis to solve its smoke problem.


The discussion is limited primarily to the air-pollution-prevention ordinances in the counties and municipalities of the United States. The history of the attempts at smoke-prevention regulation is outlined, beginning with a private suit at law in St. Louis in 1864 in which smoke was adjudged a nuisance.

The emissions prohibited and standards of measurement of air pollution by dust, smoke, and gases are mentioned briefly. The discussion closes with the following statement of the general nature of the problem:

A review of the city air-pollution prevention problems in the United States, half of which have included considerable activity, the question naturally arises as to why better progress has not been made. Similar problems have been solved essentially in so far as contaminants in city water, milk, food, and drugs are concerned. Why have there been so many "ups and downs" in air-pollution-prevention work? It is true that emphasis goes down during a war and greatly increases following the end of a war, but this does not account for the characteristic. Only recently, during an after-war period, one New Jersey county dropped the work on short notice after some 20 continuous years of outstanding work on air-pollution prevention that gained even international attention.

Various reasons have been advanced as to why air-pollution interest has "waxed and waned." City politics, lack of funds, organizational difficulties, the general "bigness" of the problem, the countless sources of pollutants, the economic impossibilities of stopping the emission of contaminants, and lack of continued public interest, all have been cited with good justification. "Campaigns" begun by public-spirited men, women, organizations, or clubs can always entrain followers for a time. People are ready to unite to correct an evil, particularly a simple, visible one such as smoke or fly ash from commercial chimneys, but a campaign can last only so long, and followers get interested in something else. An all-
Including "air-pollution" campaign is not simple, involving many items not so easily understood and crossing many interests. Sometimes the medical profession instilled in the minds of people the fear of impure water, milk, etc., proper purification resulted. The desire for cleanliness, nondestruction of property, and better visibility has not proved enough to eliminate the pollution of city air to a satisfactory extent. It is up to members of the medical profession to do their part toward better living by establishing needed facts about city air pollution that will impress themselves and then the general public. (28 refs. cited)


The Smoke Control Bureau of New York is considering changes in the ordinance under which it operates, based upon complaints of local coal merchants. These merchants charge that the ordinance operates against solid fuel in unfair limitations and volatile content are so severe whereas that on sulfur content, which they insist corrodes buildings, is relatively high, thus permitting the sale of fuel oils of relatively high sulfur content.


This is the third of a series of 12 pamphlets dealing with separate phases of air-pollution abatement as related to the chemical and allied products industries. Air pollution presents two distinct sets of problems—those of an engineering nature and those dealing with community relations. Methods of abatement are almost entirely engineering problems. The reason for abatement is almost entirely the community-relations problem engendered by pollution.

The first requirement of a sound community-relations program for any company is that the company must act properly in good faith, not only in dealing with problems of air pollution but in every phase of its business conduct. This is basic. Without good conduct and good faith, the rest of the program, no matter how skillfully conceived, will lack foundations and sooner or later will fall to the ground.

Assuming that this basic requirement is met, the next step is to let the community know that the company is acting in good faith and seeks community understanding of the company's problems and actions.


Problems are discussed in connection with the preliminary work of establishing a bureau of smoke control including the appointment of director and staff, organization and training of staff in coordination with other municipal departments, and funds needed for efficient work. Recommendations are made for rules, regulations, and procedure to expedite the work and encourage good public relations and industrial cooperation. (APB)


A discussion of air-pollution legislation. (APB)


Public sentiment against industrial air pollution has reached the point where the expense involved to prevent such pollution must be considered by the process plant owner as the price that society demands of him for permission to operate his plant; this was stated at the second process industries division and the Baltimore section of the American Society of Mechanical Engineers. If every reasonable measure to abate the discharge of objectionable products into the atmosphere is not taken voluntarily, it will be forced by more restrictive legislation.

More restrictive local ordinances and increasing publicity are evidence of the mounting awareness of air pollution on the part of the American public. Contamination of the atmosphere is due to many causes, not all of which are understood by the public. There is no pure air in nature. It contains windborne dusts, pollen, odors, and gases from natural sources.


It was decided to limit the objectives of the committee to the control of air-pollution factors that may affect the health and well-being of the people.

The most pressing problem at this time was considered to be legislation at all governmental levels. An ordinance to be effective and respected must be enforceable and enforced.

Legislation should be at the municipal level. However, it may be advisable to look to the State for technical assistance. Laws at the federal level are considered as even less desirable than State statutes.

An ordinance of the performance type is considered as one that will provide the control officer with a tool most likely to assure success. Such an ordinance would establish sensible limits for emissions of combustion, process from chemical and other industrial, and would not interfere in selecting equipment, fuel, or design. It would avoid discrimination as to fuel, cost much less to enforce, and allow for freedom of development in new design, new equipment, and new fuels.


Cement production has always involved a dust problem, solution of which has been attempted in a number of different ways. By far the most efficient method of catching dust discharge is electric precipitation.

Soon after the company went into production in the 1920's, the landowners near the plant began complaining about dust discharge. The company settled the matter by paying the landowners a total of $27,000 for dust damages incurred from 1929 to 1938.

In 1938 a two-unit Cottrell electric precipitator was installed, which collected more than 80 percent of the dust.

From 1938 until 1946 the landowners registered no objection and were apparently satisfied with that dust recovery. In 1946, however, the substantially higher production resulting from operation of a new kiln immediately overtaxed the facilities of the existing two-unit precipitator.

In March 1949 the Calaveras Cement Co. was sued by five landowners whose properties are located in the vicinity of the plant. These landowners, all of them cattle ranchers, sued for dust damages of $129,328 for an injunction preventing the company from casting dust upon their properties in injurious quantities. The issue was split, the jury deciding the amount of damages and the court handling the injunction features. The action came to trial before a jury in April of that year and resulted in damages being awarded in the amount of $7,508. A month later the court issued its injunction requiring recovery of stack dust to an 87 percent minimum.

A few days before June 30, the grace period, the company's new precipitator was placed in operation.
The Western Precipitation Corp. had assured that the new precipitator, operating in conjunction with the existing one, would have no difficulty in collecting 77 percent of the flue dust discharge. The total cost of installation was approximately $185,000. The annual operating cost for the precipitator is $26,000 before depreciation and $47,000 including depreciation.


It is believed that more high-volatile coal is burned proportionately in Indianapolis than in any other city in the United States.

In enforcement of the air-prevention ordinance the general policy is to attack the smoke and fly ash problem by controlling what comes out of the stack rather than by regulating the kind of coal that goes into the furnace.

Every effort is made to obtain the cooperation of those responsible for the production of smoke. This method has produced excellent results. Experience has proved that hand-fired water heaters cannot be fired smokelessly with high-volatile coal. The coal dealers of the city have cooperated to the fullest extent by recommending the use of a lower volatile coal in these installations. With their assistance more than 75 percent of this class of violators has been brought under control.


Refers to the frequent exposing by some of the New York city newspapers of the need for the enforcement of its ordinance regulating the pollution of the air with smoke. Official opinion is divided on including in remedial procedure action against federal and municipal governmental agencies and the large public service corporation that serves the community.

A prominent business association is reported to have asked the smoke board to go slow with the regulation and raised the matter of the cost. The public service corporation is said to have spent $17,000,000 for equipment to fight soot.

Air pollution is a big problem; but it is not an insolvable one. According to the New York deputy director of the smoke bureau, a smoke offense is fundamentally and largely a result of human incompetence or carelessness.

There are many conditions contributory to it; but most of them can be dealt with through simple engineering processes. Almost all of them could have been avoided by practicable anticipatory action. To defend, or even to seek to excuse, failure to apply preventive means to the extent of producing noticeable results is to show a deplorable lack of consideration for the communal responsibilities of business or government.


Some of the methods of operation of air-pollution activities by different State and local agencies are discussed. Some of the outstanding illustrations of such activity are air-pollution studies of the steel industry by the Cleveland Division of Air Pollution Control and the work of the West Virginia Industrial hygiene division in the Ranawaya Valley. In the international scene reference is made to the study along the Detroit River at Detroit, Mich., and Windsor, Ontario, by the International Joint Commission.

Refers to the introduction of the Joint House Resolution authorizing studies by both the Public Health Service and the Bureau of Mines. Under the proposed legislation the Bureau of Mines would concern itself chiefly with the conservation of substances now discharged into the atmosphere, while the Public Health Service would study the physiological effects of air pollution on man.

In some States the legislatures have established commissions to study the problem before enacting restrictive measures. It is up to members of the medical profession to do their part toward better living by establishing needed facts about city air pollution that will impress themselves and then the general public. (36 refs. cited)


The method of handling the issuance of permits in Minneapolis for installing of fuel-burning equipment is discussed from the viewpoints of new buildings and replacement of equipment in existing buildings.

The Minneapolis Heating, Ventilating and Air Conditioning Code and the general provisions of the ordinances governing the various trades set forth the requirements for construction, installation, alteration, maintenance, and repair of all heating and air-conditioning plants and equipment for buildings of all classes within the city. Ordinance requires that all contractors and workmen engaged in the heating, ventilating, and air-conditioning business within the city be duly licensed, and they must furnish a surety bond to Minneapolis that all equipment, material, and workmanship does strictly comply with the provisions of the ordinance relating thereto. It is also mandatory that the workman engaged in such work for the contractors be properly licensed by the city according to the various classifications.


Gives details of Detroit's methods of handling smoke violations in its procedure for instituting corrective measures under the Smoke Abatement Code. The various blank forms used in reporting violations, as smoke inspection record, legal notice of violations, and court summons, are illustrated.

1952


Describes measures taken in enforcing the Clean Air Ordinance.

The procedure is operated on a 4-month time cycle. By restricting the time cycle and assigning inspectors to districts, the total number of plants and the number of active (smoking) plants per inspector is limited. Thus, complete and orderly coverage is obtained.

Each district has an average of 500 plants. A team of two inspectors is assigned to each district, and they in turn subdivide the district for regular inspection responsibility. However, when one inspector is off duty, the other man moves in and temporarily carries the entire district. Thus coverage is properly maintained with a man who is familiar with the district.

Changes in inspector assignment are infrequent, as familiarity with plant operation and management is a valuable asset in dealing with smoke violations or other situations. Inspection of new plants and annual inspection—which is made by the district inspectors—is also valuable in keeping the inspector posted on changes that occur, and the general conditions of plants in his district.


Excessive noises have been construed in Miami courts as nuisances. Such noises include vibrations, the crowing of cocks, barking of dogs, or any noises emanating from any animal, fish, or fowl. The city desires to form an ordinance to cover noises separate from air
pollution. Information regarding such an ordinance is requested.

3774. —. St. Louis Blues. Vol. 1, February 1932, pp. 32-34.
It took 30 years of antismoke agitation to get St. Louis to pass its first smoke ordinance in 1892, and in 1926 the Citizens Smoke Abatement League was formed. The first effective action, as far as legislation was concerned, was taken in 1937. An ordinance adopted in 1937 provided for washing high ash, high sulfur Illinois coal under 2 inches in size. The washing was contested in federal court, which ruled that this clause came within the police powers of states and did not regulate a nuisance and allowed the ordinance to stand.

As soon as washing became effective, the first major improvement in the city’s atmosphere was brought about. Washing greatly reduced the sulfur content of the coal, and the improvement was readily apparent to every citizen.

In 1940 an amendment to the 1937 antismoke ordinance was passed requiring that all fuel-burning plants in the city be either mechanically fired or fired by hand with smokeless fuel.

The 1940 amendment contained a provision limiting the discharge of fly ash from chimneys to 0.75 grains per cubic foot of flue gas. In 1948 this was changed by further amendment to a limit of 0.85 lb. of dust per 1,000 lb. of flue gas. The new amendment has been followed by a campaign of testing the chimneys of the larger plants of the city and bringing about the correction of those found in excess of the ordinance limit.

In the winter of 1940-41 nearly 1,250,000 tons of smokeless coke were burned by the people of St. Louis. Only about 250,000 tons were available in the city’s market when the ordinance was passed.

The results that first winter almost exceeded the hopes of the most optimistic. Whereas, during the previous heating season, the United States Weather Bureau had recorded a total of 716 hours of thick and moderate smoke, the same period a year later produced only 197 hours—a reduction of more than 72 percent.

Chicago got tough with its smoke violators when, late in January, a smoke violation fine of $600 and $30 costs—the largest of its kind this winter—was assessed against an owner of two apartment buildings who had been put on “good behavior” 2 months ago. Another fine of $200 and $10 costs and two others were fined $50 and $10 costs each.

The Cleveland Division of Air Pollution Control was formally established on July 1, 1947, on the basis of an ordinance that permitted the organization of three bureaus. These bureaus are the Bureau of Smoke Abatement, the Bureau of Industrial Nuisances, and the Bureau of Industrial Hygiene. There is also an excellent laboratory that services the whole division. The services performed by each of these bureaus are outlined briefly.

Summarizes data presented in the February 1912 issue of Rahn und Staub, which reported not only the antismoke activity in Germany but also included information on other countries.

The oldest German injunction against smoke was passed in Cologne on June 11, 1461. This covered the complaint of neighbors around a copper and lead smelter and the harmful fumes that emanated therefrom. In 1464 the owner was ordered to cease and desist. Orders covering other plants are mentioned also.

It is the purpose of the survey to discuss the laws in Pennsylvania that deal with the regulation of air pollution and the administrative agencies that enforce these laws. More emphasis is placed on local air-pollution legislation and administration than on State administration because the administration of air-pollution programs, apart from industrial pollution, is predominantly local.

Three administrative agencies at the State level deal with the pollution of air in Pennsylvania. These are the Department of Labor and Industry, the Department of Mines, and the Department of Health.

A primary function of the Department of Labor and Industry is the promulgation of rules and regulations concerning atmospheric contaminants. Generally, this rule-making function has been delegated to the Bureau of Industrial Standards.

Further activities of this Bureau are investigations into industrial uses, health, and sanitation, and the inspection and analysis of air samples for poisonous dusts and other atmospheric contaminants. At present some 60 regulations have been promulgated, many of which aim at the control of air contaminants to safeguard the employee’s health.

Apart from the industrial air-pollution legislation administered by State agencies, air-pollution regulation has been left to the local authorities. Legal authority of municipalities to regulate air pollution is discussed, and some of the local ordinances are cited, including zoning regulations.

Gives the results of a survey made by the Industrial Hygiene Foundation to determine the need for an air-control ordinance and the proper form of such an ordinance. Some of the details of the findings of the 1 year survey are given, and reference is made to a suggested ordinance, but the provisions of such an ordinance are not included in this discussion of the report.

The two general legal approaches to air-pollution control are public or private nuisance and specific legislation. Methods and limitations of nuisance actions are discussed. The fundamentals of legislation are reviewed with an outline of the present New York City ordinance. (APB)

Some of the experiences of a smoke-regulation officer are related and the way is indicated toward a reasonable future solution of the atmospheric-pollution problem. (APB)

Prompted by a growing awareness of responsibility for conserving natural resources and for being good neighbors in community life, the chemical manufacturing industry has been paying increasing attention to controlling air pollution. Aware also of sentiment in some quarters favoring legislated control, and of the potentially unhappy consequences of an improper law, the industry selected a committee to develop the basis for a fair and workable law. The purpose in preparing this statement of sound principles of legislation is not to cast an injunction for or against air-pollution-control legislation but to create the framework
within which a proper bill can be written if it is determined that a control law is wanted.


The problems associated with air-pollution abatement in the steel industry located in Allegheny County, Pa., are discussed.

Reference is made to the Smoke Control Ordinance of Allegheny County, Pa., which was enacted June 1, 1949. Furthermore, the ordinance was written for the most part from an engineering approach with a realization of the magnitude of the problems facing industry.

Some of the specific steelmaking operations and the progress being made in satisfying the requirements of the Smoke Control Ordinance are considered. (2 refs., cited)


Dust-control standards based on “grains/cu. ft. emitted” are often misleading, since concentrations can be diluted at low cost. Many industries fail to comply with local ordinances without incurring the cost of collection equipment. The Ringelmann-chart method is also said to fail badly. Difficulties in drawing up smoke-abatement codes are briefly discussed and basic types of collectors are defined. A chart appended shows separator efficiency for all particle sizes and concentrations. (APB)


Paper attempts to recapitulate British law on atmospheric pollution and to indicate practical methods that have been adopted for its control.

Part 1 deals with the Alkali Act and its administration.

Part 2 deals with works (usually of a chemical character) not registerable under the Alkali Act and productive of emission likely to cause complaint.

Part 3 is devoted to smoke, grit, and fumes caused by the combustion of fuel. Legal considerations are set forth separately in an appendix. Particular attention is given to electric power stations, coke ovens, pottery and brick kilns, and certain metallurgical processes.

Part 4 discusses burning colliery spoilbanks and indicates means for reducing their incidence and effecting a measure of control.


Industrial solid fuel users are, in the main, sincerely cooperating with the municipalities in their programs of abating air pollution. Many industries have already gone to considerable expense in installing and using the latest mechanical equipment to suppress smoke and reduce air pollution; school their employees in the most advanced methods of fuel burning; and spending large sums of money in research to develop new mechanical equipment and processes designed to reduce their discharge of air pollutants.

However, it is submitted that careful study should be given to the peculiar technical problems of each industry so that unreasonably high standards of compliance should not be required from any industry. Many industries can reduce substantially their discharge of air pollutants by installing modern mechanical equipment and employing new processes; these industries should be required to comply with air-pollution-abatement ordinances to the full extent of their technological advancement. Other industries that encounter more difficult problems in their attempted reduction of air pollution may reasonably be required to embark in good faith on a joint research program with other industries similarly situated so that the stated purpose of clean air may be achieved as soon as possible without drastically penalizing any particular industry.


In recent years much attention has been devoted to the recovery treatment and disposal of wastes discharged into the atmosphere from the operations of business, industry, agriculture, and the public. Much reliable data concerning the problems attending thereto have been published in the last several years, but the data have been widely scattered. The Air Pollution Abatement Committee of the Manufacturing Chemists’ Association has organized and assembled this manual to accumulate the present knowledge about air pollution under one cover where it can be applied readily to such problems. Outstanding authorities in Britain and outside the chemical industries have participated in preparing 12 chapters on various phases of the subject.

In each separate chapter reliable data from widely scattered sources and the author’s own special experience have been presented. It is hoped that this consolidation will benefit planning or work to avoid or correct air-pollution problems.

Contents of the manual are outlined.


The legislation upon which the program is based is patterned in a general way after the successful water-pollution-control act. Fluorides from aluminum production plants and gases from pulp and paper mills in certain sections of the State spurred interest in the problem.

The serious consequences of air pollution in other places, such as Donora, Pa., and Los Angeles, Calif., served to emphasize the importance of preventive rather than corrective work.

A law establishing an Air Pollution Authority became effective in August 1951.

According to the Act, the discharge into the air of solids, liquids, or gases so as to cause such injury to human, plant, or animal life or to property as constitutes a public nuisance is contrary to the public policy of the State of Oregon. Proceedings to abate public nuisances created by pollution of the air may be instituted at law or in equity in the name of the State of Oregon, on behalf of the authority, by the Attorney General.

The authority has the power to hold hearings, receive complaints and evidence, and issue orders requiring compliance with its rules and regulations and the State Act. Persons, concerns, industries, etc., have the right to be represented by counsel and produce competent evidence pertinent to the matter before the authority. Appeal of authority orders may be taken to the Circuit Court.


Existing existing laws on air pollution were reviewed, and a pattern for new legislation is suggested. It is concluded that the solution to the problem of polluted air depends not on more legislation nor more stringent enforcement, but on more research.
LEGAL ASPECTS OF AIR POLLUTION

Pending completion of essential research, reduction should continue of the quantities of foreign matter released to the air. But only when the relationship to health has been ascertained of various pollutants, alone and in combination, and economical and means have been found of reducing them, will it be known how far we must and can go in clarifying the air. Until there has provided the answers to focused questions, statutory regulations are bound to be abortive.


Air pollution has become a problem too significant and nationwide to limit a discussion of its legal aspects to mere remedies for fortune. The pollution of air from industry and other causes certainly falls within the broad legal category of tort and the narrower classification of public nuisance, but legislation in these fields is generally conceived of an local in character and as proper subjects for State laws and county and municipal authorities. However, cases already determined and now pending show that the problem does have international aspects.

With the development of atomic energy, whether for industrial purposes or for war, scientists envisage the possibility of airborne radioactive waste products that might threaten whole continents and even cross oceans. Obviously, the legal problems involved in air pollution already transcend the legislative power of mere political subdivisions.

Some legal issues involving air pollution are cited. At present there is no indication that the Federal Government is apt to inject itself into the regulation and enforcement of the control of air pollution. It seems likely that the air pollution and possibility of such action will come up for future consideration. Constitutional problems that are raised in this connection are discussed.


The legal authority of the State is adequate to deal with air pollution as well as other nuisances; however, the growth of cities and the concentration of industry require a modern statute with a simple objective standard.

The 1947 Air Pollution Control Act of California created countywide Air Pollution Control Districts, which can be activated by the respective Boards of Supervisors. It authorizes a permit system, sets up the Ringelmann chart as a standard for the regulation of visible smoke, and gives authority for regulating the emission of invisible fumes by local rules and regulations. Los Angeles County now has such standards for sulfur compounds, solid products of combustion, particulate matter, and dusts and fumes. The standards can be changed from time to time without recourse to the legislature, whenever new pollutants are discovered or better tests are found.


This is one of a series of legislative reviews prepared for the State of California. It begins with a statement of the problem of air pollution and its causes. Then the review takes up experiences in various sections of California and analyzes some of the effects in terms of health, nuisances, economics, and damages to crops and livestock. Methods of abatement are next taken up, including elimination at the source, dispersal of contaminants, and zoning controls. A major section of the review deals with the legal status of air-pollution regulation on the State and local levels. (60 refs., cited.) (APB)


In any consideration of legislative requirements, one fundamental principle must be clearly recognized: namely, that responsibility for enforcement is legitimately that of a governmental agency, but responsibility for performance must be that of the individual or company involved. This chapter discusses the fundamental principles of sound air-pollution legislation and analyzes existing legislation. (60 refs., cited.) (APB)


The history of legislation relating to smoke abatement in the United Kingdom. (APB)


Legislation for the control of atmospheric contaminants should be adapted to local problems rather than copied from so-called model ordinances. Where a city, town, or village cannot afford an adequate air-pollution-control setup, the county or State should be administratively organized and legally empowered to render this service. Use can be made of existing governmental facilities and personnel with the know-how and organization in related technical fields.

Whether smoke abatement should be combined with or divorced from other phases of air-pollution control depends upon local conditions; control depends on competent administration. (60 refs., cited.) (APB)


Events leading up to passage of the St. Louis Code are outlined briefly, the present ordinance being the result of almost a century of effort on the part of the citizens.

The provisions of the present Smoke Ordinance are presented.

Although proper legislation is absolutely essential, it alone will not solve any community problem. Attendee to the proper legislation must be an overwhelming desire on the part of the citizens to rid the city of smoke and other nuisances. In addition the administration must possess the necessary courage to transmit this desire into activity. No matter how appropriate the legislation may be, it is useless unless the provisions of the law are enforced intelligently and rigidly.


The finding and recommendations made in a report of various studies in progress on the Seattle air-pollution investigation are summarized briefly.

The Seattle Air Pollution Report concludes with three recommendations that (1) an air-pollution-control ordinance be set up defining air pollution and establishing a division of air-pollution control; (2) a study be made of all smoke, fumes, and dust-producing plants; and (3) a city-wide educational program be set up.


Presents case study of the air pollution from the standpoint of legislation, meteorology, and engineering in various industries.
The provisions of the amendment to the State Health and Safety Code, enacted in 1947 are discussed, especially rule 34. The basic principle of the rules lies in the fact that the loss of dust and fumes to be allowed bears a certain relationship to the weight of material processed per unit of time.

In most of the industries involved, this rule requires a recovery ranging from 83 percent to 93 percent of particulate matter normally being emitted to the atmosphere.

Measure taken by the various industries to comply with the regulations are described.

Progress being made is evidenced by fewer days of low visibility, fewer days of smarting eyes, less crop loss this year than last, and better reports from the man in the street.


The place of the Air Pollution Control Hearing Board in the structure of air-pollution control under the California Air Pollution Control Act is delineated. Describes the legal authority of the Hearing Board and its functions, with particular reference to the granting of variances, appeals from denials of permits by the Air Pollution Control Officer, appeals from suspension of permits to operate by the Air Pollution Control Officer, the physical makeup of the Hearing Board, and some of its operating problems.


A fairly good ordinance was written in 1947, and in 1948 a new set of Rules and Regulations was prepared. The Nashville Smoke Appeal Board has the power to write and amend regulations for installing fuel-burning equipment. The current regulations have been amended five times. Most of the standards are those set by the Technical Manual of the Stokers Manufacturers Association with regard to minimum setting heights, combustion volume, and hearth area.

A thorough and practical rather than a speedy solution is sought to any air-pollution problem. A plant sometimes may be allowed to smoke periodically for several months before a solution is finally reached.


Discusses a memorandum on a national policy for the use of fuel and power submitted by the National Smoke Abatement Society to the Committee on National Fuel Policy. (APB)

REGULATION OF SMELTER SMOKE


Early experience in the West, with the effects on vegetation of smelter smoke from smelting silver-lead ores and sulfide ores, revealed little complaint from farmers in the vicinity. With the construction of large works treating thousands of tons of ore, the problem has changed greatly.

Reference is made to German and American experience in regard to injury to plants and animals from smelter smoke. The smelting companies have been compelled by the troubles they have had with farmers to look for methods of avoiding these difficulties and have worked out the problem in different ways. The various remedies proposed are enumerated and discussed in some detail.


Attention is called to the numerous suits for damage and injunctions to restrain smelters from discharging smoke and arsenic fumes into the atmosphere.

In relation to the importance of the smelting interest, a judgment for damages, assessed by a court, would be unimportant. The injunction to restrain is, however, serious and would, if issued, mean the closing of the smelter.

The damage caused by the sulfur fumes, whether slight or serious, is, if any, obvious to all observers by its effect on vegetation and is readily capable of proof. Sulfur fumes damage only vegetation. The damage from arsenic and lead is less obvious to the eye. Vegetation is affected, but herbage, on which smelter dust containing arsenic and lead or the condensed vapor of arsenious acid has settled, is cumulatively poisonous to stock. The damage caused to stock by metallic poison is less obvious to the eye than the damage to vegetation by sulfur acids. It would have to be proved by analysis of certain organs of the dead animals and other evidence. It is possible to diminish (by condensation, cooling and filtering) the metallic poisons, but it is not practicable to remove the sulfur dioxide, which is not condensable by the foregoing mechanical means.

Cases of damage by smelter fumes vary, therefore, from the extreme of all sulfur and no metallic poison, when the loss is vegetable, to those of little sulfur and much metallic poison when the vegetation flourished, but the stock feeding upon it is more or less affected.

Under the old common law, there is no defense to a suit for proved nuisance. It must be stopped and an injunction issued, no matter what the consequences may be to the defendant or how insignificant the injury. In these days there are many public enterprises and others of public importance that necessarily cause some nuisance, or annoyances and in principle the great benefit has therefore been invoked and very generally admitted.

Thus, there are two big principles invoked by those defending smoke suits: (1) The greatest benefit to the greatest number; and (2) the choice of a suitable site for the smelter. It is doubtful if any court today would grant an injunction without weighing these two considerations in defense.

It is to be hoped that out of so much litigation there will result some definite and legal principles of the old-fashioned principle, still having its adherents, that an injunction must be issued, no matter what may be the consequences to the smelter or how insignificant may be the damage, should be upheld in the case of the United States v. the Mountain Copper Co. by the Supreme Court of the United States, smelting will become a lost art and other methods of reducing oracles will have to be employed.


A dispatch from Butte states that Oliver T. Crane, master in chancery, who was appointed referee to hear the testimony in the case brought by farmers in the Deer Lodge Valley against the Washoe smelter of the Amalgamated Copper Co., has submitted his report to Judge Hunt of the United States Court, and on October 25 objections to his findings are to be heard, preparatory to a final judgment. The referee finds that the complainants, who are farmers and the farmers in the valley over which the smoke from the smelter is supposed to pass, have suffered damages, and the plaintiff, F. J. Bliss, is adjudged to be entitled to special damages of $550, that amount being sustained by him by reason of the injury done to his land by the smoke.

The main conclusions of the referee is that a tremendous injury and practical paralysis of the business of the State of Montana would follow such an injunc-
tion as has been asked by the complainants and that the farmers themselves would suffer greater loss by such disposition than they do now from the fume. It remains for Judge Hunt to decide whether an injunction is to be granted. While the referee finds that damages amounting to $350 were caused by the smoke, the fighting of this case by the Amalgamated Co. has cost the company in excess of $50,000 in a good example of an operation essential to the well-being of a community, and, indeed, to a whole State, being harassed by men whose public spirit can be questioned and whose motives are distinctly antisocial. We hope most sincerely that it may be possible for other farmers to enter into an agreement that the farmers will pay for any damage done to them, but that they cannot use that damage as a weapon for blackmail or for hindering the metallurgical operations so essential to the development of the West.

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There seems to be good prospect for a settlement of the smoker-smoke litigation which has been threatening to close permanently the Washoe smelter of the Amalgamated Copper Co. at Anaconda. Since the smelter has been closed as a result of the court action of the Amalgamated Company, the "human farmers" have made overtures for a settlement; their experience resulting from the temporary closing of the big plant and the cutting off of their principal market, has made them realize what it would mean to close the plant permanently. Representatives of the farmers have been in New York in consultation with the Amalgamated officials. It is understood that the company will, if a settlement is effected, purchase all the damaged farms at a fair valuation. In fact, the company already has acquired a number of them since the smoke litigation has been pending. Since the decision by the United States Circuit Court of Appeals in the Utah smoker cases and the temporary closing of the Washoe smelter by Amalgamated, both sides to the litigation have shown a more conciliatory spirit, and a settlement now seems probable.


Considerable excitement was caused in Butte and throughout the State by news received from Washington that President Roosevelt was considering the advisability of going to the courts for the purpose of enjoining the operation of the Washoe smelter at Anaconda because of the injury to the forest reserves in the vicinity from the fumes of the smelter. Two years ago the farmers in Deer Lodge Valley, adjoining the smelter, instituted an action in the Montana Federal Court for the same purpose, claiming that their farm products were ruined by the sulfur fumes. Many months were consumed in the hearing of the case before a special master in chancery appointed for the purpose, and volumes of testimony were taken. The findings of the master in chancery were submitted to Judge Hunt some months ago and are now held under advisement by him preparatory to rendering his decision.

The news was received in Butte with indignation and disapproval on all sides. The closing of the smelter by temporary injunction or otherwise would also mean the closing of practically all the larger mines in the Butte district and would directly affect more than 100,000 persons who depend upon the mining industry for their livelihood. Mass meetings in Butte, Anaconda, and other mining centers were held, and resolutions were telegraphed to the President and the Montana representatives at Washington urging that no action be taken until an opportunity be presented for hearing both sides of the controversy. As a result of the telegrams and a conference held at the White House between President Roosevelt and the representatives of the Amalgamated Copper Co., it is probable that no action will be taken by the Government until the feasibility of installing fume consumers at the smelter is determined.


The incident on the report that the Government would institute action to enjoin the further operation of the Washoe smelter at Anaconda has subsided, and business is resuming its normal condition. The real basis for the scare, which the report created, was the popular misconception of the powers of the President with regard to the situation. On a more sober thought, it was realized that the President has no power to close the smelter. True, he could request the Department of Justice to bring an action to enjoin the operations, and the Attorney General could file a bill in equity on behalf of the Government; but the same long-drawn-out legal battle would follow that came about when the Deer Lodge Valley farmers instituted their action for the same purpose. In the case of the farmers against the company, Judge Hunt refused to issue a temporary injunction pending the determination of the action, and it is probable that the same result would follow should the Government begin action.

3308. —. Chronology of Mining in April. Vol. 85, 1908, p. 917.

The United States Smelting, Refining & Mining Co. secured a modification of the perpetual injunction against its Salt Lake smelter and permission to run 3 years to demonstrate the efficiency of its baghouse plant to prevent damage by smelter fumes.


The sulfur-smoke problem is the subject of two interesting developments. At the Selby works, near San Francisco, experiments (reported to have been highly successful) have been made to neutralize the sulfur dioxide to trioxide and the precipitation of the latter as sulfuric acid by static electricity. It is believed that something important will come of this. At the United States works, near Salt Lake, the process of neutralizing the sulfur trioxide in the smoke by zinc oxide has been introduced successfully. This permits the smoke of roasting and matte-smelting furnaces to be filtered through woolen bags. It has been tried long enough to prove that danger to the bags can be eliminated in this manner.


The mayor of San Francisco has appointed a committee to investigate the smelter-smoke question and prepare a report to be presented to the San Francisco Board of Supervisors to prevent the issuance of an ordinance detrimental to the erection of the San Bruno smelter by the Guggenheim interests.

3311. —. Salt Lake City. Vol. 85, 1908, p. 333.

The United States Smelting & Refining Co. is operating its lead smelter at Murray under a modified decree of court, which was obtained through a compromise arrangement with a majority of the farmers who appeared as plaintiffs in the trial of the late smoke suits. The United States company is still working its lead smelter at Bingham Junction, but the management contemplates drawing the fires within the next 30 days, unless some similar compromise can be arranged in the meantime. There is no doubt that the smoke from the several plants has damaged vegetation; but the problem can be and probably will be solved by moving the smelters beyond the Garfield smelter or some other place beyond the agricultural sections. However, until this trouble is settled, some of the smaller mines will suffer for the lack of proper facilities to handle their ore.

3312. —. Salt Lake City. Vol. 85, 1908, p. 474.

Officials of the United States Smelting, Refining & Mining Co., in a petition filed with the Federal court
for a modified decree permitting the operation of the smelter at Bingham Junction, declare that the company has solved the "smoke problem." It is stated that the process, which the company proposed to employ, involves the introduction of zinc oxide fumes in the flues; the sulfuric acid in the smoke combines with the zinc to form zinc sulfate, which is caught in bags in the houghhouse without damage to the fabric. It is claimed that the gases from both blast furnaces and roasters can thus be passed through the houghhouse, removing all deleterious substances before the gases are allowed to escape into the atmosphere. The company has applied for a patent on the process. It is believed that the farmers of the valley in the vicinity of the smelting works will approve the company application.

3813. ——. Salt Lake City. Vol. 85, 1908, p. 519.

The smelting outlook in the Salt Lake Valley appears to be brightening now that the United States Smelting, Refining & Mining Co. states that it has finally mastered the "smoke problem." The drawback to the baghouse treatment of smelter smoke has been the frequent failure of the bags, but the company thinks this difficulty has been overcome by the introduction of zinc oxide into the flues; this combines with the sulfuric acid and makes a zinc sulfate, which collects on the bags. Occasionally, the bag fails and has to be replaced, but the number of failures is small, for only 4 or 5 of a total of 2,076 bags used had to be replaced during the last month.

Almo coincident with the application of the United States Smelting, Refining & Mining Co., for a modified decree, there was held a mass meeting of farmers, business men, and others affected by the closing of the smelters south of Salt Lake City, at which the opinion appeared to be almost unanimous that the company should be granted the same privileges as those granted to the American Smelting & Refining Co., and that, consequently, the decree of the court should be modified.

3814. ——. Salt Lake City. Vol. 85, 1908, p. 782.

The Federal Court has suspended the injunction against the United States lead smelter, which means that it will be opened again. As the company will immediately begin the construction of the new converter-rotors, and the installation of other devices for the purpose of controlling the fumes, it will probably be 60 days before any furnaces are started. About 800 men will be put to work at once. The United States Smelting, Refining & Mining Co., according to the decision of the Court, is permitted to carry on its operations, carrying 25 percent sulfur, amounting to one-third of its capacity. It must remove all solid emanations that issue from its roasters and blast furnaces. Among these emanations are those compounds of lead, copper, arsenic, and antimony, which appear in an impalpable form and which, according to the testimony before the court, are the substances that have done the damage in the past. The company must remove all traces of sulfur trioxide or sulfuric-acid gas. The maximum amount of sulfur dioxide or sulfuric-acid gas that may issue from the smokestack of the company is placed at 0.75 percent. All fumes issuing in any part of the smelting process must be collected and sent through a single smokestack. Only lead ores can be treated by the company.

3815. ——. San Francisco. Vol. 85, 1908, p. 120.

For some months the Selby Smelting & Lead Co. of San Francisco has been conducting experiments to suppress the evils of smelter smoke and has succeeded in condensing the sulfurous fumes almost entirely. The system is a mechanical one, electricity being used. The experiments, conducted on a practical scale, have been so successful that instructions have been received to install a complete plant at the smelter on Carquinez Strats, near Vallejo Junction. The sulfur is eliminated from the smoke and is converted into sulfurous acid.


The supervisors of San Mateo County have passed an ordinance placing smelting works erected in that county (adjoining San Francisco) under the supervision of the county health officer and providing stringent conditions under which they may be allowed to operate. The ordinance was presented by the Home Protection Association, composed of wealthy residents of the Bay counties near the site of the Deep Point Guggenheim smelter at Point San Bruno. The ordinance was passed without giving the smelter people any hearing on the subject to contradict the ex parte statements submitted to the supervisors. It is believed that the ordinance, as it stands at present, virtually prevent the erection or operation of the smelter where several thousand men would be employed. Citizens of South San Francisco have, since the passage of the above ordinance, held a meeting to protest against it and have appointed a committee to take the matter up. The supervisors doubtless did not know of the adoption of the recent invention for preventing damage by smelter fumes by the Selby Smelting & Lead Co., but even if they did not, they were justified in putting the matter in this shape.


The Board of Supervisors of San Mateo County, adjoining the city and county of San Francisco, has adopted an ordinance that those smelters engaged in the operations of smelting and providing for their supervision, which is intended solely to prevent the completion of the Selby smelter at Point San Bruno. While it professes to regulate and license smelters, it virtually prohibits their operation in San Mateo county, as the Selby Smelting & Lead Co. could not carry on work under its provisions; at least, they will not attempt to do so. The ordinance is based, it is claimed, on the English law adopted in 1906, which provides for the escape of fumes from furnaces and plants containing sulfuric acid. These plants, in England, are operated in large cities, and a smaller quantity of gas or fumes is allowed to escape than would be allowed in sparsely settled regions. The English law has no such provision as the San Mateo County ordinance that the gas containing sulfur trioxide or sulfuric anhydride per cubic foot of smoke, gases, or fumes, shall be allowed to escape into the free atmosphere. After the San Mateo supervisors adopted this ordinance, efforts were made to get the San Francisco supervisors to adopt a similar one. No smelter is projected in the latter county, but it was argued that the fumes of the smelter in San Mateo County might injure the vegetation in Golden Gate Park, San Francisco. The mayor of San Francisco appointed a committee of citizens to report to the supervisor the damage liable to be done if the Selby smelter at San Bruno is put in operation.


It may be stated that a mass meeting of farmers of Valley, near Martinez, Contra Costa County, was held recently; and $40,000 was pledged to fight the smelters at Selby and Bulls Head Point; and an endeavor was made to get the supervisors of the county to adopt the same ordinance as that in force in San Mateo County. The supervisors appointed, at their request, a committee of three to consider the subject. It is to consist of a farmer, a smelter representative, and a third man chosen by these two.
Incorporate their town, within the limits of which is the smelter site. The Burlingame citizens think this is a move to take the jurisdiction of the smelter site from the county supervisors to that of the council of South San Francisco, the latter place being in favor of having the smelter built. The San Mateo supervisors have adopted an ordinance so restrictive that it virtually prohibits any smelters.

In response to an invitation from attorneys representing the Selby Smelting & Lead Co., the Board of Supervisors of Solano County will visit the works for further inspection of what is being done in installing and maintaining appliances to handle fumes. Pending a settlement, the smelting plant is closed down, and shipments of California and Nevada lead ores, formerly sent to Selby, are being consigned to the United States Smelting Co., Bingham Junction, Utah.

There was an interesting test recently applied in the controversy between the smelter people and the residents around San Francisco Bay in California. The managers of the Selby Smelting & Lead Co. claim that Benicia suffers as much from the fumes from the oil and bowler works down the Bay as the city of Benicia, and to prove this, by giving the people a chance to smell the other fumes, closed down the smelter a few days, during which time as much complaint as ever was made about the fumes. For this reason, the company does not wish to be held entirely responsible for the objectionable condition of affairs. The Benicia people will, in their litigation, now have to bring more conclusive evidence than heretofore as to the smelter fumes being a nuisance.

A matter of great importance in connection with the mining industry of the State is the attitude of the ranchers of the Deer Lodge Valley toward the Washoe smelter at Anaconda. These ranchers ask for an injunction closing the smelter and for the payment of damages to livestock and land. A vast amount of trouble and expense has been gone to by the Washoe company in the preparation and submission of its side of this now famous case. Master-in-Chancery Crane, before whom the case was argued, gave an opinion to the effect that he believes the sulfur in the smoke causes no damage to animal or vegetable life, but that the arsenic is damaging to both, and that if the injunction were granted and the smelter closed the damage to the ranchers would be greater than if the injunction were allowed to continue in operation. The case is now before Judge Hunt of the Federal Court. The closing of the Washoe plant, the largest concentrator and smelter in the world, would be a serious blow to the mining industry in the State.

This article issues a warning as to what might happen to the mining industry as a result of the organization of the proposed Federal Bureau of Mines. Should some person, suffering from the perennial smelter-smoke dispute, in a western metallic district beseech an impetuous President to issue an injunction against a smelter that its smoke was destroying the adjacent forests, Government property.

Reference is made in this connection to the "blundering interference of the mining industry by immature officers of the Forest Service."

The fear is expressed that, proving that the solution is for the smelter to make sulfuric acid, as has been done in Tennessee, a smelter in some other location, as Alaska, for example, would do the same.
advice might be given by a "bureau expert" who knows nothing about the market for sulfuric acid, but this advice might be accepted by the President.

The Antismelter Association of Alameda County, which is on the opposite shore of San Francisco Bay from the site of the proposed Selby smelter at Baden, is actively engaged in getting alleged facts that may prevent the completion of any smelter on San Francisco Bay. The committee on information has made a report in which it makes certain allegations as to what would happen in San Francisco if the smelters were put in operation.

San Francisco lies within a 10-mile radius of the place where the smelter is to be built. According to the weather bureau, the wind during 2 months of the year blows from the smelter toward the city, and 5 months of the year the wind is toward the east. In other words, for one-sixth of the time, the San Francisco Peninsula would be getting the maximum destruction from the fumes, while for the balance of the year, although the damage would be lessened on account of the direction of the wind, as shown at other smelters, the harm would still be great. The smelter at Baden is to have a daily capacity of about 5,000 tons of ore. There would be discharged into the atmosphere from this smelter every 24 hours about 1,250,000 cu. ft. of fumes containing 1,500 tons of sulfur dioxide. In 1 year there would be spread over the neighboring country more than 10,000 tons of arsenic trioxide.

The smelter at Baden would probably give employment to many men, create a town about it, increase the shipping in and out of the port, and raise the value of the land in its vicinity. Operated as they have been, smelters will do in the future what they have done in the past, and we cannot but feel that the good accomplished by the location of the smelter at this point would be far outweighed by the harm that would be done, including the disastrous action upon cemeteries, gardens, parks, and the state of the public health.

The above extracts from the report are given merely to make men, create a town about it, increase the shipping in and out of the port, and raise the value of the land in its vicinity. Operated as they have been, smelters will do in the future what they have done in the past, and we cannot but feel that the good accomplished by the location of the smelter at this point would be far outweighed by the harm that would be done, including the disastrous action upon cemeteries, gardens, parks, and the state of the public health.

The opposition to the construction of any smelting plant on the shores of the Bay of San Francisco seems to be gaining ground, and it is doubtful if such plants can be completed and operated in the face of it. A large plant was planned at Point San Bruno, where coke, and other materials could be delivered by water, and a large sum was spent. The purchase of land, grading, and building foundations when work was stopped on account of opposition by the residents of Burlingame and other places near the smelter in San Mateo County. An organization was subsequently formed in Alameda County on the opposite shore of the Bay from the smelter site. Now, to secure cooperation, the Bay Counties Antismelter Association has perfected a permanent organization in San Francisco, the expressed object being to prevent the building of a smelter on the Bay shore south of San Francisco.

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The smelting companies evidently have a hard fight ahead of them in convincing these opponents that the smelting business may be carried on without injury to other interests. Like the Antidebris Assay Board, which really killed the hydraulic-mining industry in the drainage basins of the Sacramento and San Joaquin Rivers, the antismelting party will be hard to convince contrary to first impressions. These persons are not in the slightest degree interested in the mining industry of the State and care little or nothing for its advancement or whether the closing of smelters will injure it; and they are indifferent to any industrial advantages that the operation of a large plant may bring locally.

Experiments were made at the Utah Consolidated smelter, near Murray, Utah, in 1905 and 1906, to determine if a practical method could be devised to absorb and utilize the gases from the roasters, which were discharging 400 tons daily of sulfur dioxide into the air. Plans and estimates had been furnished by a New York chemical engineer for a coke tower plant to absorb the SO2, but this would require 40,000 tons of water daily if a 1-percent solution were made, and the disposal of this amount of acid water would be as serious a problem as that presented by the smoke itself.

George C. Westby, a chemist employed at the smelter, discovered that the reverberatory slags could be decomposed by a dilute solution of sulfuric acid and the copper contained in them recovered. Experiments were conducted along these lines, which showed that finely ground slag was readily decomposed, the iron and other bases, including copper, going into solution. It was also found that moistened slag was readily attacked by the hot gases (300° to 500° F.) taken directly from the roasters. If the absorption of the smoke and the solidification of the slag could be accomplished in one operation, the process would be simplified and the amount of water would be greatly reduced.

After various experiments and modifications of the apparatus, it was concluded that the Westby-Sorensen process for the advantage of the filtering of the fumes could be accomplished at a few smelters, in that it retains all the dust and fume, removes the sulfur gases, and recovers the metals in the slag. The cost of installation and operation would be about the same as for a baghouse of equal capacity.


The Selby Smelting & Lead Co. has received an order from the Supervisors of Solano County, to discontinue the roasting of ore until such time as the Cottrell fume-precipitation plant has been successfully placed in operation, or until November, when the cessation of the trade wind will relieve the town of Benicia from obnoxious smoke. This order, effective immediately, would have resulted shortly in the complete closure of the smelter but for the remarkable invention of Mr. Fred G. Cottrell, who is the Professor of Physical Chemistry at the University of California. The Cottrell invention has so thoroughly demonstrated its practical efficiency as to lead to its adoption, and the installation should be in working order within 2 weeks if the necessary transformers for the electric current arrive in time. The Cottrell apparatus eliminates carbon, dust, and sulfur compounds, whether sulfuric acid or sulfuric anhydride. Thus, it saves everything of value in the smoke and will prove profitable.

The Selby smelter, accordingly, will not be likely to shut down, and the company has officially announced that it will continue to receive shipments of ore, concentrate, and bullion without interruption. But for the timely completion of the Cottrell plant, however, enormous losses would have been entailed on mine owners scattered throughout California and Nevada, as well as upon the Selby company and its large force of employees.

A remarkable feature of the situation is that the smelter, although occasionally responsible for causing discomfort to the citizens of Benicia, has been a less grievous offender than a neighbor whose contributions to the sulfurous atmosphere in Carquinez Straits have escaped notice because of the prevalent fashion of regarding a smelter as necessarily a nuisance. A useful article by Mr. E. H. Messiter on the detecting and mitigating of smelter fume appeared in our columns. If the citizens had made actual tests, such as those described there, and had known at the same time what was going on at the Selby works, the order from the supervisors would not have been issued. On May 28, the Selby smelter, which is 23 miles from San Francisco, on San Pablo Bay, was shut down; that is, the roasters and blast-furnaces were put out of operation and remained idle for 1 week. Nevertheless, 3 days after the shutdown, the people of Benicia, just across the estuary, complained of the smoke from the smelter, and 27 leading citizens made a formal protest. The fume that annoyed them manifestly came from the Union Oil Co.'s refinery. On passing the Selby works on the overland train, a nasty smell should not be impeded to the smelter but to the oil refinery, which is less than a mile to windward. Its unpleasant fume usually reaches the traveler just when he is close to the smelter. The incident affords a good example of the manner in which an unfair prejudice is created against the smelter through misconceptions, for which some scientific men are partly to blame.


Smelter troubles in Montana have assumed a new character. Instead of local complaints, the Federal Government is the complainant, the President declaring that the forests are of more worth than any other interests.

Threatened proceedings against the Washoe smelter have aroused earnest protests from the citizens of Butte. They insist that the livelihood of 75,000 people must not be swept away, at least by summary action. The consequent suffering would undoubtedly be extreme. It is gratifying to learn that no precipitate course will be pursued. A commission will be appointed to investigate.

Some of the effective methods of suppressing smelter smoke are cited. It is stated that the smoke from the smelters is manifested by a popular feud. The agitation is often the result of mere personal ambition, sometimes with the hope of graft. Speculators have been known to buy large tracts of land so situated as to be in the drift of smelter smoke for the express purpose of profiting by damage suits.

Agitation against the smelters has become a menace to one of the most important of American industries, and the public has become supersensitive to the point of fancying inconvenience where none actually exists. The matter cannot be settled by national legislation, as the right to regulate extends down to the merest petty board of county supervisors, but the United States Government has now an opportunity to render a lasting service in this matter. The complaint will find its way to the Montana smelters and turn into a blessing by the appointment of a competent commission, with a representation of distinguished scientists, attorneys, and business men, to investigate the question of damage done and feasible abatement of the trouble in a broad way, not with reference to Montana alone. The findings and recommendations of such a commission, followed by intelligent departmental regulations based upon them for rational protection of the national forests and of the smelting industry, would establish precedent that would settle the controversy wherever it has existed. These regulations would speedily become crystallized into case law and set a limit beyond which local officials would not dare to go, as well as setting a barrier against unjust suits arising from the lower courts. It would give the smelters a chance to live without being outlawed.

1999


Reference is made to the hazy notion about mining and smelting held by the general public, which seems to feel that smelting plants are a nuisance. Figures showing the value from a monetary standpoint of the
mining and smelting industries in California and Nevada are presented.

However, notwithstanding the vast interests involved, if 20 or 30 farmers in Solano County and the citizens of the small town of Benicia are listened to, the Selby plant may be closed indefinitely.

The cause of the complaint against the smelting company is the smoke coming from the stacks of the plant. The company has spent $100,000 in improvements to prevent possible damage from fume and has eliminated entirely the elements causing the original complaint.

Investigation of the surrounding circumstances indicates that the offender is not the smelter plant but an oil refinery in the vicinity. The odors are not from fumes produced by the smelter but from gases and vapors emitted from the oil refineries.


The United States Circuit Court rendered a decision dismissing the case of a complaint against the Anaconda Copper Mining Co. and Washoe Smelter Co. and ordered each party to the action to pay its own costs. The decision was final. This celebrated case was begun in May 1905 and cost the farmers of Deer Lodge Valley $100,000; the cost to the companies is not known, although it must have been many times that incurred by the farmers. The case is one of the largest that any other Federal court has ever heard. The decision established another precedent.


According to the New York Sun, the officers of the Amalgamated Copper Co. asked the Government experts who went to Montana to investigate the smelter nuisance if they could suggest a remedy. The only thing that they could offer was converting the poisonous products into sulfuric acid and building a pipeline to the Pacific Ocean, dumping the product into the sea. The Butte correspondent of the Sun says that this suggestion was made in sincerity; yet it is felt that the Government experts must have been joking.


At the continued hearing of the case of Bliss against the Anaconda Copper Mining Co. held at Helena, the possibility of further abating the injurious effects of the Washoe smelter fumes was taken up. Testimony was given on behalf of the company to the effect that the methods now employed by the smelter were the most advanced known to science and that the introduction of any other method would mean the expenditure of several millions of dollars with merely problematical results.

3837. ——. Deer Lodge County. Vol. 87, 1909, p. 971.

Government chemists are investigating the smoke problem at the smelter with a view to ascertaining a method by which the fumes may be utilized for the manufacture of sulfuric acid for other commercial purposes.


In connection with the legal activities in which a petition to enjoin the operations of the immense plant of the Anaconda Copper Mining Co. at Anaconda was denied, the judge made a 2-day trip to the valley.

He found the complainant's bill to the effect that the Deer Lodge Valley and the country adjacent to the smelter were barren and desert-like to be grossly inaccurate. The land and vegetation lying within a quarter of a mile of the smelter were visibly affected. Outside of this limited area, however, there was the appearance of healthy natural conditions of successful cultivation and of such crop growths as are usually seen in the valleys of the State. There was nothing in the physical appearance of the complainant's farm or of the valley that indicated unusual or abnormal conditions.


A conference has been held between the Board of Supervisors of Contra Costa County, Calif., representatives of the Selby Smelting & Lead Co., the Peyton Chemical Co., and the Mountain Copper Co., and certain citizens of districts of the farmers declared that it was not the intention or force any burden upon the smelting interests. The smelting men declared themselves ready to meet the requirements of the new ordinance. They wanted 90 days' time, but this was reduced to 30 days.


The Federal Court handed down a decision in the so-called smoke case, wherein the farmers of the Deer Lodge Valley sought to have the smelter of the Anaconda Copper Mining Co. at Anaconda, Mont., closed, because the gases were ruinous to vegetation and live stock. In essence, the court denied the application for an injunction closing the smelter, and no damages were awarded to the complainants, with the exception of one who was granted $450 a year for damages since 1904.

The Court found that there had been some damage from arsenic in the vicinity of the Washoe smelter, but no appreciable damage from sulfur.

The decision said: "Finally, in the last analysis when, in connection with the attitude of complaint direct and vicarious, we weigh the uncertainty of his proof as to the amount of past damage done to his land, or of future damage to be done to his pasture by the acts of these defendants, together with the fact that he has not resorted to a court of law to recover any damages at all, and balance these facts against the great injury that would be done to many interests, I hold that, under the evidence as he has submitted his case, discretion, wisely, imperatively guided by the spirit of justice, does not demand that the injunction as prayed for should issue."

The Court ordered a further hearing in the matter to ascertain if there was not a possible means of treating the flue dust to reduce the quantities of arsenic now released from the stack and stated that it may there-after make any specific order, such as may be equitable and right, and that it will retain the bill in diligent effort to afford all the relief reasonably possible under its allegations.


In the Solano County courts in California the case against the officials of the Selby Smelting & Lead Co. has been deferred. The suit is for violating an injunction that prohibits the company from operating its works during certain months of the year, when the prevailing winds are supposed to carry fumes across Carquinez Straits from the smelter into Contra Costa County. This suit is instituted by about 20 farmers and the residents of the small town of Benicia against the smelting company for alleged damages from fumes. The Selby company has some millions of dollars invested and employs about 500 men, while about 3,000 persons are interested in its operation. In 1908 the company handled $25,200,000 worth of sulfur and $1,500,000 worth of lead, making about $35,000,000 in all. In addition, the company manufactures large quantities of copper, lead, sheet lead, shot, white lead, cartridges, etc., so it is an important factor in the industrial progress of California and adjoining States. Its activities are also on the increase. For instance, in June of this year it handled about $4,000,000
In gold alone, or nearly half of the total gold yield of the country on the basis of last year’s total production. Yet a small town and a few farmers threaten to curtail the one basic benefit to the mining industry of the Pacific coast, as well as to the city of San Francisco. It is expected, however, that in the final adjudication, it will be found that the noxious fumes have their origin in works that are making asphalt from California crude petroleum, rather than from the smelting works; but this is yet to be proved.


At the conference of the counsel with the judge in the Amalgamated case, the company described, in detail and with much lucidity, the processes in use for recovering arsenic from the smeltery fumes and dealt with the advantages and the more numerous disadvantages of the methods proposed for overcoming what the farmers style the “smoke nuisance.” The company representative said that the arsenic in the ores varied from minimum quantities to 2½ percent, usually occurring in small quantities. He stated further, that 90 percent of the ore that came to the smelter was sent to the concentrator, where 90 percent of the metal is removed and thrown on the dump. Of the arsenic that reaches the smeltery in the ore, some is dumped with the furnace slag, a part is recovered in refinery dressers, and the rest goes into the flame in the form of white fume, consisting principally of the oxides. He told how the arsenic is recovered from the fumes by redistillation and recovery and advanced the statement that the method employed at Washoe is the most thoroughly known. In reply to a question from the attorney of the Amalgamated Copper Co., the representative said there were only two other smelters in the United States that collect the arsenic from the fume, one being at Everett and one at Salt Lake.

The methods for the extraction of arsenic were classified for the court as follows: (1) Cooling processes: (a) water spray; (b) admission of air; (c) radiation; (d) freezing. (2) Filtering processes; (e) baghouse; (f) friction; (g) centrifugal gas cleaners. (3) The Cottrell method. In commenting on the smelting method the representative emphasized the difficulty of disposing of the acid mud formed and stated that a plant adequate for the Washoe smeltery would cost $3,000,000. He disposed of the baghouse method by saying that a working plan would cost $2,750,000, that the expense of its operation would amount to $1,850 per day, with a recovery of arsenic valued at $294, and that the life of the bags would be short. The installation of a radiation-cooling system would cost, in its estimation, $1,200,000, and would not be efficient. For the freezing system, the pipes alone would cost $4,000,000, and the cost of operation would amount to $12,000 per day. The system, further, has not proved practicable. A plant using zinc oxide as a neutralizer would cost $3,000,000 and would require 500 tons of zinc ore daily. With regard to the Cottrell method, he said that its application was not practicable on a commercial scale, except under very peculiar conditions. The representative concluded that if the friction system now used at Great Falls were successful, Anaconda would adopt it, although its installation would cost $2,000,000. Many letters were received by the court and the company embodying schemes for collecting the arsenic, but the men who made the suggestions seldom realized the quantity of fume to be treated, and, consequently, the ideas were of little value.


This refers to the struggle between the Farmer’s Protection of Shasta County, California, and the smelters. A demand has been sent to the latter that on or before October 1, said smelters should offer to the Association some tangible proof that immediate steps are being taken to stop said fume nuisance. It is physically possible to abate the smelter-fume difficulty, but it has not yet proved economically possible to do so.

The difficulties in the way of eliminating the evil are outlined. According to the clashing interests of the people involved, the farmer has been in a position to benefit more largely by the presence of the smelter than he could hope to do were the smelter driven away. For actual demonstrable injury sustained by reason of fume, he can readily collect damage in court. Thus, these difficulties may be equitably adjusted if no attempt is made to overreach and demand damages in such sums as might give rise to suspicion of blackmail.

1910


The injustice of the order of the United States Government in closing the Bully Hill smelter in Shasta County, California, is deplored. This act came as a surprise to the company as the farmers had declared that no damage was being done and they had no complaint to make. Special agents of the Bureau had also said the timber was not being damaged.

The two smelters, the fumes of which are doing damage, are spending ¼ to 1 million dollars to obviate the smoke nuisance by removing the solid particles from the smoke and the stronger acid in SO₂. The smelters expect to have the fume-catching devices in operation in a few weeks after the date set for closing them.

The welfare of the workers depends more on the continuous operation of the smelters than on any little truck gardening they do.


The “smoke case” is apparently renewed this fall. The Attorney General of the United States, acting on representations made to him by the farmers of Deer Lodge Valley, filed a suit against the Washoe Smelter Co., alleging that vegetation was being destroyed by the fumes from the Washoe smelter at Anaconda. It is the same case that was heard before, but the findings in the case were not considered satisfactory, so the Government was induced to take up the matter. Expert chemists are now in the Deer Lodge Valley taking samples of the soil and examining the trees, vegetation, and grain. The Anaconda Co. has experts also making tests, and the testimony is expected to be even more extended than it was in the smoke case of more than a year ago. Considering the dryness of the season, the crops in the Deer Lodge Valley never looked better, and, of course, the Anaconda Co. will take advantage of this to show that the alleged poisonous gases and the arsenic from the smoke of the smeltery are not as destructive to the grain and vegetation as represented by the ranchers.


The recent visit of the Attorney General of the United States to Butte and Anaconda has directed attention to the suit that the United States Government instituted against the Anaconda company several months ago to remedy the alleged smoke evil of the Washoe smelter at Anaconda. The Attorney General, accompanied by attorneys representing all parties interested, made a brief visit to the plant and the farms and lands which the smoke is alleged to have damaged. Unless the Government and the Anaconda company can come to some agreement for the lessening of the evil effects of the smoke, it is probable that the litigation will be long drawn out and will eventually reach the United States Supreme Court.
The smelting situation in Shasta County appears to be serious, the opposition to the smelting operations being not so much from the farmers as from the United States Forest Service. The Ballykla smelter has been permanently closed, while the Balakla smelter is closed pending development of the plant to employ the Cottrell process. What success this plant will have remains to be seen. The Mammoth Copper Co. has installed a baghouse, which enables two furnaces to keep in operation, but it is feared that the company with its present installation may not be able to operate any more furnaces.

The Shasta County Farmers' Protective Association has planned the Balakla smelter at Coram continue operations pending installation of the Cottrell process for condensing fumes. The company has been operating only one furnace lately, but the Farmers' Association has insisted on this being closed. It is contended that the farmers took this action in order to be fair to the Mammoth Copper Mining Co., which is running only two furnaces because its baghouse can only handle the smoke from that number. In order to keep within the court decree the other two furnaces remain idle. The Balakla managers wanted to run one furnace running until completion of the installation of the Cottrell condensing plant, but the farmers were not willing to wait that long. The Balakla Co. does not like to lose its skilled employees, for it is difficult to get them together again. Notices will be posted asking all the staff to remain if possible. Meantime, the entire smelting plant must remain closed.

Asserting that operation of the Washoe smelter is destroying vegetation and timber and injuring approximately 1,000 square miles of operation in Jefferson, Silver Bow, Deer Lodge, Powell, and Granite Counties, suit was filed in the United States District Court at Helena, March 16, on behalf of the United States against the Anaconda Copper Mining Co., for an injunction to close the plant. Special assistant to the attorney general, who is in charge of the case for the Government, said that it was the purpose to compel the company to install appliances that will render thenoxious fumes harmless.

Reference is made to suits against other smelter companies in California and Tennessee, which the Justice Department said converted the harmful fumes into a valuable product; neither the smelters nor mines were closed. It said that the suit against the Anaconda Co. would be pressed vigorously, but it was hoped that the company would cooperate voluntarily to terminate existing conditions.

The United States smelter at Bingham Junction, now known as Midvale, is running at full capacity and treating a large tonnage of lead ore. About 1,100 tons of charge are smelted by the furnaces per day, of which approximately 800 tons represent ore. Since the closing down of the Knight plant at Silver City, the United States Co. is receiving the ores of the Colorado and Iron Blossom, as well as from other mines of the Tintic District. At the present time the lead furnaces are the only ones in operation, as the copper plant is being redesigned to meet the requirements of the Federal court, which will allow the smeltery to operate as long as the percentage of sulfur dioxide escaping with the fumes does not exceed 0.75 percent by volume. The lead plant, with its baghouse and treatment of the fumes by zinc oxide, comes well within the limit set by the court. The success of this treatment has caused the United States company to design a plant along similar lines for its copper furnaces. This plant will be separate from the lead plant and will have its own baghouse. The fumes will be neutralized here as from the lead furnaces by zinc oxide. This is produced in a separate furnace in which the dust from the zinc mill is mixed with coke and burned to zinc oxide. The zinc oxide fume is led into the roaster flue near the roasters and travels about 1,500 feet before reaching the baghouse, mixing with the gases on the way. An excess of zinc oxide is used to neutralize the acid fumes and protect the bags, which would otherwise be quickly destroyed.

One furnace at the Ballykla smelter at Coram has been blown in and coupled up with the Cottrell fume-condensing plant, which is now handling the smoke. The Cottrell installation at Balakla is an extensive one, entailing an expenditure of $150,000. Cottrell personally superintended the installation and is in charge of it at present. The cessation at the Balakla and Ballykla smelters has worked a severe hardship, not only on those companies but on the mining men of Shasta County generally, and it is a cause of congratulation that the farmer at least, is enabled to resume operations.

The smelter-smoke problem is being settled as reported in Shasta County on the basis of the Utah decree. The baghouse process will be installed at the Mammoth plant at Kennett, and it is understood that the Balakla plant at Coram will adopt the same. It is now in use at the Selby Smelting & Lead works. The time for installing the devices has been extended for several months. The manager of the Shasta County Farmers' Protective Association has been in the East consulting with the directors of the copper companies, and an attorney has been instructed by the executive committee of the farmers' association to prepare the necessary papers for the foundation of a suit in the circuit court, whereby the legality of all the proceedings will be settled.

The new baghouse to be installed by the Mammoth Copper Co. at its smeltery at Kennett, in Shasta County, is to contain 2,960 woolen bags 18 inches in diameter and 30 feet long. The American Bridge Co. has the contract for the structural steel, which will weigh about 800 tons. The fumes after passing through a series of pipes will enter the baghouse and finally reach the air free from all substances deleterious to vegetation through small stacks. The total cost is estimated at $300,000. There are 60 men employed on the baghouse construction work. 400 ft the smelter, 550 at the mine and about 60 men at Quartz hill, where silicious ore is mined for a flux to the copper ores of the Mammoth. The cost of installing the Cottrell process at the Coram smelter, Shasta County, is estimated at only $100,000.
About a year ago the farmers of Shasta County began an agitation against the smelting companies to compel them to use devices to prevent damage from sub-
furious fumes; the committee which visited the Bully Hill smeltery at Winthrop reported unanimously that no complaints had been made against that particular plant. The timber nearby had all been cut before the plant was built, and outside a radius of 2 miles no damage to plant life could be noticed. However, the Bully Hill company received notice from the United States Forest Bureau that a smoke-consuming device must be put in so that no damage could be done to timber in the Shasta National Forest. The device was ordered to be put in within 90 days, though, subsequently, 20 days more were allowed. No such notices were needed for the Mammoth plant at Kennett and the Balaklala at Coram, as they are under contract with the Shasta County Farmers' Protective Association to install and use smoke-consuming devices. It is contended that there is much less sulfur in the smoke from the Bully Hill than from the other smeltries in the county, and the officers of the company are still making applications to the Federal Bureau. If the Government insists on its present position, it is probable that the Bully Hill smeltery at Winthrop will be closed.

Similar action on the part of the Government resulted in closing the extensive smeltery plant of the Mountain Copper Co. at Keswick, some years ago, and the company erected a new smeltery on the shores of Suisun Bay, above Martinez. The Bully Hill Co. is now negotiating with the other smelters to treat its ores.

The Shasta County Farmers' Association agreed to demand that the Balaklala smeltery be closed. The company has been granted time to finish matters on hand preparatory to a shutdown or until the completion of the Cottrell process designed to correct fume troubles. The company will accede to the demands of the farmers.

Balaklala Co.—One furnace has been started up, the Cottrell process being used in connection therewith. The latter has been reported as giving satisfaction, but apparently several difficulties have not yet been definitely overcome.

Mammoth Copper Co.—It is rumored that this company will erect a new smeltery at Keswick.

Mammoth Copper Co.—The third furnace was recently blown in, but the baghouse was unable to filter so much smoke, and, consequently, the furnace had to be blown out.

The conflict between copper smelters and adjacent landowners, growing out of the injurious effect of sulfuric acid on vegetation, is almost as old as the copper industry itself. For many years the world's copper ores were shipped to England or Germany, when Swansea and Freiberg monopolized the smelting industry. It is therefore, natural that the problem of smeltery smoke should have had its first serious consideration in Europe. In the early days little attention was paid to the chemistry of copper metallurgy; in fact, it is still in its infancy as compared with the metallurgy of iron. The effect of the smoke nuisance, however, was only too apparent. Royal commissions were appointed to investigate experiments after great preliminary experiments had been abandoned, rather than face prospective trouble. It is not the purpose of this article to incite sympathy for the copper smelter but to tell how some of them have overcome their difficulties.

The friction system, designed for the recovery of fine dust from furnace gases, is described. This system, installed at Great Falls, Mont., had not been in use long enough to obtain knowledge of its efficiency, but it seemed of interest to have an explanation of the system.

Reference is made to the truce prevailing at the time between western smelting and ranching interests which gave opportunity for a summary of the results achieved by metallurgists in condensing fume and deacidifying furnace gases. German and British experience in trying to solve the problem is discussed, with a brief historical statement. Figures showing the great cost of installation and operation of some of the systems are given.

The paper closes with a résumé of methods of treating furnace gases that are applicable in modern prac-
tice. Some of the methods are: Use of separators and Theisen centrifugal washer for iron blast-furnace gases; use of regenerative-chamber system for open-hearth steel-furnace gases; the deposition of dust in long flue-and-chamber system partitions to offer a surface to the gases and aid precipitation for lead-silver furnace gases; and the centrifugal scrubber for antimony furnace gases.

Of the other methods proposed for recovering the sulfuric acid for rendering the gases harmless, it is difficult to realize that any can be used successfully in the plants that produce such quantities of gas as the larger western smelters make every day.

It is conceivable, however, that the problem will be solved in good time when a market is found for sulfuric acid at a future date through the industrial development of the Western States.


Judicious compromise is the order of the day in disputes arising from smelter fumes.

Reference is made to the famous Montana suit wherein Judge Hunt dissolved the injunction obtained by the farmers against the Anaconda company, his decision being broadly based on the principle of the greatest good for the greatest number. He regarded smelting as of primarily greater importance than agriculture to the Deer Lodge Valley and dissolved the farmers' injunction on the ground that the smelting company had exhausted all means known to modern technical skill to control the enormous volume of fume that the plant was producing.

In a similar case in Shasta County, Calif., a compromise has been effected between the litigants. By the terms of the California compromise, the Mammoth Copper Co. agreed to equip its plant with neutralizing and baghouse devices for wholly suppressing the sulfuric and arsenious acids now discharged into the air. According to the compromise, the gases finally discharged into the air should not contain more than 0.75 of 1 percent of sulfur dioxide by volume.


With the closing of the plant of the First National Copper Co. at Coram, by the farmers' association of the district, and the suspension of the Bully Hill at Winthrop on account of a Government suit, the smelter-fume question in Shasta County, Calif. has recently reached an acute stage, and with copper between 12 and 13 cents per pound and curtailment facing the large producers, there is little inducement for the smelting companies to expend large sums in additional equipment. Last spring the farmers formed the Shasta County Farmers' Protective Association, and a compromise was effected with the Mammoth and First National companies whereby the solid particles should be removed from the smoke and the SO2 diluted before the fume passed into the air. To attempt to relieve the situation by the erection of acid plants is at present out of the question, as the estimated production of H2SO4 by the smelters of the county is 1,200 tons 60° B. per day, the market, aside from that supplied, being about 40 tons.

The effect of the smoke near the plants is cumulative, especially on evergreens, such as the pines, but it is largely overcome by cultivation and irrigation. The farms in the Anderson District, while opposing the smelters the strongest, produced record crops last year when a greater volume of smoke was thrown into the air than at any other period in the history of smelting in the county. A certain damage is wrought on both grain and garden truck, but the local market for these furnished by those engaged in copper smelting has far more than compensated for the losses. It is, however, easier to lay the blame for failure of crops on the smoke than to investigate the deterioration of the soil or various blights, and the companies' pocketbooks have been accessible as every effort to avoid lawsuits has borne fruit. While the spirit of those who have been the leaders in the movement against the smelters companies has been one of fairness and compromise, the majority, with short-sighted policy, have believed in obtaining "all the traffic would bear" demanding their "pound of flesh," even at the risk of killing the business that has supplied over 90 percent of the trade to the merchants of the district and brought the county from comparative obscurity to one of the leaders of the State.


The Sprague process for the removal of all fume, solid matter, and sulfuric acid from furnace gases, by filtration through fabric, after a preliminary chemical treatment of the gases to make filtration possible, is described. The necessity for the removal of these substances is twofold—to prevent possible damage to vegetation and to recover valuable metals otherwise lost as fume.

This process has been in successful operation at a lead smeltery in Utah for 2 years. The process is equally adapted to copper smelting, and the United States Court has recently granted the United States Smelting, Refining & Mining Co. permission to start a copper plant at Bingham Junction on the showing made.
COST OF AIR POLLUTION


The harmful effects of smoky fogs are outlined as involving loss of light, entailing large expenditures on artificial light; expense from disorganization of traffic; damage to buildings, decorations, and property of all kinds; loss of life; and injury to health and vitality. An estimate of the annual cost of fogs in London is given as 3 to 5 million pounds.

In view of the need for conserving coal and abating the increasing evils from smoky fogs, the use of substitute fuels, such as gas and electricity, is suggested. The key to the solution of the smoke problem lies in supplying cheap gas for heating and cooking. Experience in the United States is cited as an example of the benefit to be gained by the substitution of gas for coal.


The slow destruction by the smoky atmosphere of the various works of art in public and private collections is described. The absolutely priceless Greek, Assyrian, and Egyptian works of sculpture in the British Museum are slowly but surely decaying. Precious manuscripts are subject to the same deterioration. If only from commercial interest—the collections in public galleries and museums and in private homes are worth millions of dollars—the wisdom of risking the destruction of such priceless possession is questioned.

The solution offered is to arouse public opinion to force legislation to control the cause of the threatened destruction of such valuable objects.

1907


Devoted largely to figures showing damage in London. (MIR—Bib.)

1909


Editorial statement of loss entailed by inhabitants of smoky cities. (MIR—Bib.)

1910


Quotes authorities to show that smoke means waste. Notes some evidences of progress in the campaign against smoke. (MIR—Bib.)

1911


Offers proof that "smoke abatement is primarily a measure of economy." (MIR—Bib.)


Losses due to the smoke nuisance are discussed. The results of inquiries in a number of cities indicate that smoke causes more than $500,000,000 damage each year in the destruction of merchandise, defacement of buildings, tarnishing of metals, injury to human life and plant life, greatly increased labor and cost of housekeeping, and losses to manufacturers due to imperfect combustion of coal.

1912


Popular article giving some figures of loss by smoke and discussing use of Kehoe smoke tight chart for determining density of smoke. (MIR—Bib.)

1913


A prominent Pittsburgh citizen contributed $40,000 to the Department of Industrial Research of the University of Pittsburgh to make an investigation of the smoke problem. The results of this study are briefly detailed in this paper.

An interesting history is presented of the early experiences with bituminous coal that dates as far back as the year 850 A. D. The smoke costs to people who do not make it include the following: (1) Cleaning bills of office buildings, hospitals, stores, homes, and individuals; (2) lighting bills; (3) damage to goods in wholesale, retail, and department stores; (4) laundering.

Chemistry of soot is discussed, and the following points of smoke nuisance are presented: Damage of smoke to property generally, effect on vegetation, smoke and weather, and effect of smoke on the health.


In this report an attempt is made to estimate the minimum cost of various items of damage about which data could be obtained for the city of Pittsburgh. The itemized bill shows partial cost to the smoke maker, to the individual, to the household, to wholesale and retail stores, and to quasi-public buildings. (13 refs. cited)

1914


Smoking is a costly habit, whether the smoker happens to be man or a town. Persons who have regarded the "smoke nuisance" mainly as an aesthetic problem will be startled by the revelations of investigations of the smoke of Pittsburgh from the practical viewpoint of dollars and cents.

The items of Pittsburgh's yearly smoke bill are:

- Cost to the smoke maker: Imperfect combustion of fuel (of which smoke is the outward and visible sign), $1,520,740. Better methods of stoking would not only do away with most of the smoke but would effect a saving of 21.7 percent in the present fuel consumption; in other words, about one fifth of the utilizable fuel of Pittsburgh factories now "goes up in smoke" and is a dead loss.
- Cost to the individual citizen: (1) Laundry bills, $1,500,000; (2) dry-cleaning bills, $750,000. These figures do not represent the total laundry and cleaning business of the city but merely the excess over what these items would cost under ideal conditions of smoke regulation. The same principle applies to the other costs.

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quoted below in connection with other economic effects of the smoke nuisance. Pittsburgh is the greatest laundry town in the country, notwithstanding the fact that, with its large population of unskilled laborers, it has a higher percentage of citizens who do not patronize the laundries than almost any other city. The annual per capita laundry business is $5.12; about one third greater than that of the average American city. Dry-cleaning bills are far larger in Pittsburgh than in most other cities, despite the fact that Pittsburghers generally eschew light-colored clothing to such an extent that their city has come to be known as "the mourning town."

Cost to the household: (1) Interior painting, $350-000; (2) sheet-metal work, $1,008,000; (3) cleaning and renewing wallpaper, $520,000; (4) cleaning and renewing lace curtains, $360,000; from $75 artificial lighting, $84,000. Houses in Pittsburgh are painted every 3 years, while in most other cities the houses are painted every 6 or 8 years. The sheet metal of roofs, gutters, spouts, etc., deteriorates twice as fast in the smoky atmosphere of Pittsburgh as in cities of average freedom from smoke and therefore needs to be renewed twice as often. It also needs repainting about twice as often. About 10,000 Pittsburgh households have their wall paper cleaned once or twice a year by a professional cleaning company. Cleaning costs range from $57 artificial lighting, to $1,500 at a haberdasher's, $2,000 at a florist's, and $3,000 at a stationer's. The extra precautions to prevent damage to goods by smoke include additional labor, extra wrapping of cloth, books, or other articles when stored, screens to keep out dirt, covering for goods, weatherstrips on windows, etc. The extra cost of cleaning requires no explanation. As to item (4), it is stated that 30 percent of the artificial lighting in Pittsburgh is reduced by atmospheric conditions for which smoke is responsible. Under this item account is taken not only of the effects of diminished daylight but also of the reduced efficiency of electric and other lamps resulting from the accumulation of soot on globes and shades. The losses experienced by department stores have been reckoned separately on account of the diversity of their stocks. These stores report damage to merchandise up to $25,000 and other items in proportion.

Cost to wholesale and retail stores: (1) Merchandise, $1,650,000; (2) extra precautions, $450,000; (3) cleaning, $750,000; (4) artificial lighting, $650,000; (5) department stores, $175,000. Annual damage to merchandise due to smoke in typical stores, exclusive of department stores, ranges from $57 artificial lighting, $1,500 at a haberdasher's, $2,000 at a florist's, and $3,000 at a stationer's. The extra precautions to prevent damage to goods by smoke include additional labor, extra wrapping of cloth, books, or other articles when stored, screens to keep out dirt, covering for goods, weatherstrips on windows, etc. The extra cost of cleaning requires no explanation.

Cost to semipublic buildings: (1) Office buildings, $90,000; (2) hotels, $22,000; (3) hospitals, $55,000. The additional expense in these instances is analagous to that borne by private households. It is found that Pittsburgh office buildings use 15 pounds of cleaning powder per square foot per month, as against 11 required in New York, Boston, Philadelphia, Baltimore, or Washington. The bill totals $9,944,740 per annum; and no attempt has been made to include such items as depreciation in the value of property, absence of various industries that are virtually excluded by a smoky atmosphere, and, last but not least, injury to human health.

1916


Industrial life and with it the very existence of a great many cities depend on coal. Therefore, it is not surprising that cities have had great difficulty in solving a problem that arises from coal consumption—the smoke problem. The economic phase is discussed. Unlike many other social nuisances, abatement of the smoke nuisance would result in direct and immediate gain both to the public at large and to those who are chiefly responsible for the problem.

1917


The metallurgist in charge of the Salt Lake City station has been directly interested in the investigations being conducted at the Anaconda smelter to improve the smoke conditions there.


The economic loss (estimated) by smoke in London, Pittsburgh, Philadelphia, and Chicago is given. The amount of money spent in Chicago for water and sewage disposal is compared with that spent for smoke prevention. Chicago's appropriation for 1923 was about $15,000,000 for the water department, about $75,000,000 for the sanitary and health departments, and $25,000 for smoke.

The people are reminded that it is they who are making the smoke. Everybody should get together, work together, help each other, and work with the smoke inspector. They should have a smoke abatement ordinance, but use the law only on persistent violators. Instructions for firing furnaces smokelessly are given. If heating equipment is operated correctly, 80 percent of soot and smoke can be prevented.

The effect of smoke and soot on health cannot be estimated in dollars; it is scarcely possible to calculate the cost of being sick or half sick. The possibility should stimulate action to abate smoke.

1929


The economic losses in Chicago, III., due to smoke in the atmosphere are considered.
1931


Pittsburgh once had the enviable reputation of being "the smoky city," but apparently the smoke nuisance is worse in New York and in London. The campaign waged during the past 10 years to reduce the amount of air pollution in Pittsburgh has reduced the amount of smoke deposit to only 31 percent of its former value, is a vast improvement, and is now 83 percent of London's smog. It is estimated that New York's smoke pall is costing the city $96,000,000 annually. The withered and dwarfed appearance of the trees and shrubs in Central Park, New York, is doubtless due to the excessive smoke in that city.

1937


The economic aspect of the abatement of air pollution is discussed. The crux of the matter is given as the joint nightmare of increasing coal production while decreasing atmospheric pollution, that is, an attempt to decrease the effect by increasing the cause.

1938


The subject is treated from the viewpoint of what smoke abatement should mean. Figures are given for the cost to Indianapolis and to Milwaukee for damage done by smoke. The totals, according to the estimated figures, are $9,920,000 a year to the people of Milwaukee and $16,000,000 to the people of Indianapolis. Smoke abatement means reduction; it does not mean elimination. An adequate force is necessary to carry out an adequate program of smoke abatement.

1941

3885. SCIENCE NEWS LETTER. $2,700,000,000 Declared Yearly Cash Cost of Smoke. Worst Effect, however, Believed to be on Health. Pneumonia Incidence Highest Where Smoke is Thick. Vol. 39, 1941, p. 267.

Actual cost each year to the United States on account of smoke is $2,250,000,000. In addition, there is incalculable cost to health. The wastage of coal, gas, and oil fuels, due to incomplete combustion, which causes smoke, amounts to $200,000,000. In addition, the extra cleaning of buildings and laundering or drying of clothing and house furnishings and their shortened life account for the remainder of the staggering total.

Probably the worst aspect of smoke is its effect on health. Although this relationship is difficult to evaluate, correlation of smoke and high incidence of pneumonia seems to have been clearly established. Much evidence exists that death rates from pneumonia and other respiratory ailments are greater in smoky industrial centers than in small urban communities. The effect of smoke in depriving people of sunlight is another broad aspect of the smoke problem, one that probably has an important bearing on health.

Wider use of gas as a fuel is advocated to overcome smoke troubles, because it can be burned more efficiently and completely than some other fuels.

1946


A recent survey of hotel owners, shopkeepers, doctors, office buildings, gardens, and all connected with building repair or renovation in St. Louis shows that since the smoke ordinance became effective in 1940 great improvements have been noticed in (a) cleanliness of buildings and cost of cleaning; (b) life of metal work; (c) life and health of plants; (d) reduction of interior decoration costs; and (e) reduction in evidence of eye, nose, and throat infections. (FA)

1947


At the annual conference of the National Smoke Abatement Society, held at Brighton from October 24 to 26, the annual cost of atmospheric pollution in Great Britain caused by 3 million tons of smoke was assessed at £50 million (apart from such effects as ill health), in addition to the waste caused by unburned gases. The Department of Scientific and Industrial Research had shown that black smoke from an industrial chimney might waste 10 percent of the heat of the coal. Smoking domestic chimneys were also antisocial. The Ministry of Fuel had reduced the emission of SO₂ and smoke by 10 percent in a single year. It was stated that 2 1/2 million tons of coal (5 cwt, per family) was wasted annually in smoke at a cost in damage to buildings and property of £2 million per week a conservative estimate. Total tonnage was equivalent to the work of 10,000 miners and the work of a greater number of people employed in making good the damage. The city of London had recently obtained statutory authority to require all new fuel-burning installations to be approved by the Health Department and was awaiting a report on district heating in its bomb-shattered areas. Soot deposits in rural areas were said to average at least 10 tons per square mile per annum. Two-thirds of the 3 million tons emitted in solid form was too fine to descend by gravity. Carried upward to the lowest temperature inversion (33,000 feet), some 40,000 tons usually hovered over the country, cutting off light and causing a loss in agricultural productivity of 20 to 30 percent. (FA)

1948


The benefits derived from the reduction of smoke in St. Louis are cited as improvement in health, with accompanying reduction in doctor bills; beneficial effects on plants; increase in civic beauty through reduction of injury to external surfaces of buildings; with reduction in cost for their frequent renovation; decreased necessity for interior decorating and cleaning; reduction of spoilage in stores; and the saving in electricity.

These are the testimonials of business and professional men of St. Louis who have had the opportunity to observe the results of 5 years of smoke abatement upon the people of the city reflected in their own businesses. They say that experience shows that eliminating three-quarters of the smoke from the atmosphere has not only made the atmosphere more aesthetically pleasing, but has made the area a more beautiful city, improved the health of the residents, lowered housekeeping costs, and increased business profits.

To the question "Does smoke abatement pay?" St. Louis answers a most emphatic "Yes!"

1949


Three questions that involve the economics of air pollution are: The overall economic costs and gains of air pollution; the overall economic costs of air pollution control; and the economic point of diminishing returns in attempts to control air pollution.

The cost of the damage from smoke in various parts of the United States has been estimated at $8 to $20 a person. The authors' estimate is $10 a person. The cost of air-pollution control is borne by governmental agencies and by individual enterprises and...
Industries. The 1949 budgets for abatement programs in 30 cities amounted to more than $1,500,000.

Some of the individual companies make a profit from the control of air pollution, while others get no financial return from the expenditure of large sums in such control. Based on direct expenditures of governmental agencies and private industries, $100,000,000 is being spent annually in the United States to control air pollution.

The abatement of air pollution is a long-term problem that can be achieved to the benefit of all only if the net cost to industry, the companies can be brought within the point of diminishing return. To be most effective, the liabilities of air-pollution control should be converted into assets, and complete abatement should not be attempted.


Most air-pollution problems in Los Angeles County stem from emissions that are a functional part of plant operation, and careful operation and design cannot always prevent these emissions. Frequently, the only way that they can be prevented is by adding to the plant mechanical equipment designed to remove the emissions. The rules and regulations of the Air Pollution Control District of Los Angeles that affect smoke, dust, and fumes are summarized briefly. In the 18 months following the formation of the district more than $15 million was expended for control equipment for removing air contaminants, and 47 dumps were eliminated in the county. It is anticipated that within 18 to 24 months essentially all sources of pollution will have been corrected to the extent possible with available equipment and engineering knowledge.

1950


A $200,000-construction program has placed Westinghouse Electric Corp. plants "well within the limits" of the Allegheny County smoke-abatement ordinance. The company reports that its smoke-elimination program—begun after the war before the ordinance was beyond the proposed state—now is essentially completed. It included rebuilding a steam-regenerating unit at East Pittsburgh and enlarging its combustion chamber by 50 percent; replacing parts on four main boilers to improve their efficiency; rebuilding East Pittsburgh refuse-burning boiler; and installing additional boiler equipped with modern combustion system at Tafford works.


The amazing amount of money it costs a city to tolerate smoke nuisance was recently revealed by the director of the Bureau of Smoke Control, New York City. He estimated that with effective air-pollution control in New York City, the general cost of living for residents can be reduced at least $50,000,000 a year.

Some of the costs of the smoke nuisance are readily apparent. For example, it is estimated that smokeless operation of heating plants would result in greater overall combustion efficiency, which alone would save $8,000,000 annually. However, this saving is minor compared to other losses from smoke and other forms of air pollution from combustion of fuels, refuse, and various industrial processes. Eighteen items are cited that would represent a potential annual saving of $45,766,000 with smoke control.

Other costs of air pollution are cited, most of them of a hidden nature, where still further savings can be made for New York residents with effective air pollution control. It is pointed out that the value of real property is decreased by smoke; the examples given illustrate that rentals are lowest where smoke is heaviest. New Yorkers also pay an estimated $2,000,000 annually for drugs and $1,000,000 annually to doctors for ailments attributable to polluted air, while $30,000,000 may be the annual cost of working days lost for the same reason.


Progress was made in 1949 in reducing the dust nuisance in one of the two huge dry-process cement plants in Oglesby, Ill. This plant is spending $30,000 to install three high-velocity Van Tongeren cyclone-type dust collectors on the plant's rock dryers. This equipment is designed to capture at least 95 percent of the dust particles.

Reports were made on what other cities had done or were doing to eliminate or control cement dust. One of the many interesting facts revealed by this survey is that at one plant the dust was extremely heavy in spite of its being a wet-process plant. The survey indicates that some smaller communities have dust-control ordinances, whereas some large cities do not. Cities where cement plants are near but not in the municipal limits form a separate category.


Fifty-two suits, totaling $2,213,350, have now been filed in Federal Court in Pittsburgh, alleging damages caused by the Donora, Pa., smog in October 1948. The petitions name the American Steel & Wire Co., claiming the firm was negligent. In filing answers to some of the suits, the law firm representing the company denied liability. (FDH)


At one of its generating stations Consolidated Edison is experimenting with a television camera focused on one of the tall smokestacks from the roof of an adjoining building. The image of the stack is reproduced on a screen in the boiler control room.

This control room is near street level, some 450 feet below the top of the stack. The camera keeps the operator in constant touch with the appearance of the stack and makes it possible for him to note immediately any abnormal condition that results in smoke. Formerly, it was necessary for the operator to summon a supervisor to inform the operator, a time-consuming operation.

Consolidated Edison testing various television components in its field installation and has not decided whether to make the installation permanent. All the company will say is that the idea "holds promise." In recent years the New York utility has spent more than $16,500,000 in equipping its generating stations with the most up-to-date smoke-elimination apparatus.


In the study of any question involving the disposal of any waste product economics plays an important role. The necessity for disposing of gases, fumes, and dusts has often arisen as the result of destruction of property or life or because of the nuisance they produce. Consequently, such operations are seldom thought of as being profitable. In many instances, they are not because of the great dilutions involved. However, the good public relations that result from the elimination of noxious and annoying gases and fumes often pays handsome dividends.

Sometimes, an economic and engineering study of the waste products escaping into the atmosphere will show that much money is being lost to the winds.

In one instance, a copper smelter in Tennessee, after being forced to install a sulfur dioxide scrubber and a
sulfuric-acid converting plant, found that for a while it was making more money from its byproduct sulfuric acid than from its main product, copper.

In the small manufacturing plants where the amounts of offending materials are comparatively small yet are present in sufficient amount to be annoying to the surrounding community, it is often found that the price of remaining in business is the installation of proper waste-disposal equipment. In such plants much ingenuity must be exercised so as not to install equipment of such magnitude that it would appear that the tail were wagging the dog.

Obviously, the manufacture should approach the question of the disposal of waste gases as he would any other pollution problem. It must be considered as a necessary part of manufacturing operations and should be included in the operating cost.

1951


Air pollution has become more than just a "big" problem; it appears to be one of the industry's biggest. In 1948 and again in 1949 more than 100 Oregon farmers, orchardists, bulb growers, and others claimed damages of several million dollars in a series of suits filed against Reynolds Metals Co. because of fumes emanating from the corporation's large aluminum plant at Troutdale, Oreg. The trial, which lasted for many months, came to an end in May. A United States district judge has ruled recently that the plaintiffs are entitled to substantial amounts to compensate for the damage done to their trees, gladioli, lilies, and livestock, and their attorneys have been directed to submit a detailed schedule of evidence specifying actual damages suffered.


American Steel & Wire Co., a subsidiary of United States Steel, has made out-of-court settlements of about 130 damages suits as a result of the Donora, Pa., smog disaster, which killed 22 persons in October 1948.

The company said that it was prepared to prove that the principal cause of the disaster was due to a number of circumstances as well as to the effluents from its plants. However, the company decided not to defend itself because of the costs involved in fighting more than 130 suits and chose to settle out of court for a lump sum representing a small amount of the total amount claimed.

The amount of the settlement was not disclosed, but the figure has been estimated at $25,000 or about 5 percent of the total $4,043,000 claimed.

1952


The sum of $200,000,000 has been spent or is committed to be spent by the various industries in Allegheny County, Pa., for apparatus or equipment that will reduce the air pollution in the area. Industries in Pittsburgh have contributed about $95,000,000. The remaining $105,000,000 has been expended by industries in the county outside the city.

Up to the present time, owing primarily to the rapid purchase of diesel locomotives, the railroads are credited with approximately $108,000,000 of the total. The steel industry, so far, has spent or is spending $21,000,000 and central-station power plants, $6,500,000; the remainder, approximately $4,500,000, is credited to other industries.

Some details of a research program to continue until 1954 are given.


What has been done and is being done at the Cleveland plant of Du Pont to reduce emissions and thus contribute to a general improvement in the atmosphere of the Cleveland community is discussed.

Industry's sincerity in the endeavor to reduce air contamination is strongly demonstrated in the amount of money being spent for abatement and control facilities, particularly so, when rarely is there any monetary return on such investment.

Obviously, end results are the only true measure of accomplishments, but capital investment is an indirect yardstick. The capital investment of the Du Pont Co. in air-pollution abatement facilities in operation at the end of 1951 somewhat exceeded 5 million dollars; in addition to this amount, 1½ million dollars was authorized for facilities not yet installed.

For the past 5 or 6 years capital expenditures at the Cleveland works for air-pollution control facilities have ranged from $20,000 to $50,000 per year and have averaged about $30,000 per year of new money invested; $7,000 to $10,000 per year is spent for cost of operating and maintaining these facilities. Modernization of production facilities is, of course, not included in these figures, although modernization does contribute significantly to reduction of emissions.


With the growing recognition of the injurious effects that arise from air pollution, municipalities, groups, and the general public are significantly concerned with resulting damages and with the costs and benefits that arise from controls. It is estimated that the annual direct losses from air pollution in the United States are at least $1,500,000, or about $10 per capita, and that industry and local units of government are spending approximately $100,000,000 each year to combat damages.

Determination of losses caused by air pollution and appraisal of costs and benefits of air-pollution controls involve economic measurement, and this in turn requires the use of sound economic standards and principles. This paper deals with (1) the purpose of economic evaluation, (2) instead of costs and benefits, and (3) steps in measurement. Each of these phases is considered primarily in regard to underlying relationships or principles involved in an economic appraisal, from a public and private viewpoint, of the effects of air-pollution damages and of the costs and benefits of control of air pollution.


The memorandum has been submitted to the Committee on National Fuel Policy. The importance of the social costs resulting from the use or misuse of fuel, particularly those costs due to the emission of smoke, are stressed. Adherence to the recommendations of the Fuel and Power Advisory Committee on domestic appliances, prior approval of new industrial fuel-burning installations on grounds of fuel efficiency and smoke abatement, and the education of boiler-house attendants and furnacemen are urged. Financial incentives and subsidies should be considered for both domestic and industrial installations, and consideration given to assisting solid smokeless-fuels production. Finally, it is emphasized that a long-term fuel policy should be drawn up, even if only in outline. (APB)
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