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Subject Category: WASTE DISPOSAL

UNITED STATES ATOMIC ENERGY COMMISSION

A PRELIMINARY FIELD SURVEY OF AIR
CLEANING ACTIVITIES AT ATOMIC
ENERGY COMMISSION FACILITIES,
SEPTEMBER-NOVEMBER 1950

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Waste Disposal

A PRELIMINARY FIELD SURVEY OF AIR CLEANING ACTIVITIES

AT

ATOMIC ENERGY COMMISSION FACILITIES

August T. Rossano, Jr., Leslie Silverman and Melvin W. First

September - November, 1950

Price \$ 0.45

Available from the
Office of Technical Services
Department of Commerce
Washington 25, D. C.

CLASSIFICATION CANCELLED

DATE FEB 28 1957

For The Atomic Energy Commission

H. R. Canale
Chief, Declassification Branch TC

School of Public Health
Harvard University
Boston, Massachusetts

Contract No. AT(30-1)841

February 1, 1951

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II

A PRELIMINARY FIELD SURVEY OF AIR CLEANING ACTIVITIES
AT
ATOMIC ENERGY COMMISSION FACILITIES

August T. Rossano, Jr., Leslie Silverman and Melvin W. First
September - November, 1950

I. ABSTRACT

During the period September 6 to November 9, 1950, members of the staff of the Harvard University School of Public Health visited eleven principal Atomic Energy Commission research and production sites. The purpose of these visits was to observe air and gas cleaning installations and to consult with plant officials concerning these activities. This report contains information on air and gas cleaning methods and equipment now in use and their performance, where available, at certain sites. Pertinent comments and recommendations are included on present and proposed installations.

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II. GENERAL RECOMMENDATIONS

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Specific recommendations concerning the individual sites are noted in the detailed discussion of air and gas cleaning facilities (Section IV). The comments below are those which apply generally to air cleaning activities at all AEC facilities.

1. In order to evaluate the performance of present air cleaning systems, it is suggested that representative data be obtained on particle size and concentration as well as collection efficiency. Where no cleaning equipment exists but effluents are discharged through stacks or openings, information on concentration and particle size is also of importance.
2. Where air precleaning is practiced or contemplated tests should be made to determine what proportion of the dust load reaching the final filters represents outside atmospheric dust. The life of final filters can usually be increased by efficient precleaning of supplied air if this source is indicated to be a major portion of the dust load.
3. Filtering performance can be improved by use of a variable gradient filter (density and fiber size variations). This is a filter series in which each layer is progressively more efficient than the preceding one. Such a filter has large storage capacity for the collected aerosol particles without excessive resistance increase. The first few layers remove the coarse particles and reduce the load on the final fine filter layer, thereby increasing overall service life.

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4. In general the isolation of dust-producing operations and removal of atmospheric contamination at the source are highly desirable since this reduces the volume of air to be cleaned, facilitates filter maintenance, and increases the life of the filters in the main air cleaning system.
5. The splitting of radioactive exhaust air into high, medium and low activity air streams lends itself to efficient and economical air cleaning procedures and should be applied wherever practicable.
6. It is preferable to place blowers downstream of the air cleaning system so that this equipment will be under negative pressure and all leakage of air will be inward, thus reducing external contamination.
7. Wet collectors, while not of high collection efficiency, offer the advantage of protection in the removal of pyrophoric dusts. Their limitation to removal of coarse and readily wetted materials is suggested.
8. When effluent air or gas from cleaning devices handling extremely toxic materials is discharged to the atmosphere the stack height should be such as to provide a margin of safety should the cleaning equipment fail or be only partially operative. Actual stack height will depend on such factors as meteorological and topographical conditions, but in no case should it be less than 50 ft.

The Harvard University Air Cleaning Laboratory provides service as a central clearing house for information on air and gas cleaning problems. The effectiveness of this service depends

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largely on the cooperation of the various sites and contractors in submitting for consideration such information as specific ventilation and air cleaning problems, results of tests on air cleaning equipment, and performance data.

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III. INTRODUCTION

In accordance with the objectives of the air cleaning contract between the AEC Engineering Division, Washington, D.C., and Harvard University, Dr. L. Silverman and Dr. M. W. First of the Department of Industrial Hygiene and Mr. A. T. Rossano, Jr., Sanitary Engineer, U. S. Public Health Service, on assignment to this Department made a series of visits during the period September 6 to November 9, 1950 to the principal AEC research and production sites. The objectives of these visits were:

1. To observe and study air and gas cleaning activities at the various atomic energy sites.
2. To become familiar with the air and gas cleaning installations and equipment, methods and needs at the various sites and to collect design and performance data.
3. To consult with responsible plant personnel on air and gas cleaning problems.
4. To acquaint the responsible plant officials of the services available to them from Harvard University under the terms of an AEC contract.

The locations visited as well as the dates and persons interviewed are listed in Table I.

Table II in Appendix I summarizes the information on air cleaning equipment, capacities, and performance at the sites visited.

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TABLE I

Schedule of Sites Visited

AEC SITE	ADDRESS	DATE 1950	OPERATIONS VISITED	PERSONS INTERVIEWED
Mound Laboratory	Miamisburg, Ohio	9-6	Laboratories, Incinerator	Belcher, E. A. Walker, Hamilton
Argonne National Laboratory	Chicago, Illinois	9-7	Machine Shop and Foundry, Chemistry Building	K. E. Walker, Ege, Holmes
Los Alamos Scientific Laboratory	Los Alamos, N. M.	9-11	CMR #10, J-2, D and DP West Buildings, Incinerator	Jette, Shipman, Schylte, Leary
Radiation Laboratory University of California	Berkeley, California	9-15	General Research Building	Nielson, Browne
Knolls Atomic Power Laboratory	Schenectady, New York	9-18	Laboratories, Incinerator	Leech, Simon
Hanford Engineering Works	Hanford, Washington	9-19- 9-20	Buildings Number 314 and 221 (Canyon)	Musser, Beaton, Weidenbaum, Adley
Ames Laboratory	Ames, Iowa	9-21	Metallurgy and Research Buildings	Lord, Spedding, Fisher
Oak Ridge National Laboratory	Oak Ridge, Tennessee	10-9- 10-10	Buildings Number 706C, 706D, 706HB, 706A, Physics of Solids Building, Nuclear Reactor, and Machine Shop (Y12)	Eister, Stockdale, Gest Western, Tench
Westinghouse Atomic Power Division	Bettis Field, Pittsburgh, Pennsylvania	10-30	Hangars, Main Building	Barnes
Mallinckrodt Chemical Works	St. Louis, Missouri	10-31	Uranium Production, Laboratory	Caplan
Brookhaven National Laboratory	Upton, Long Island, NY	11-9	Hot Laboratory, Nuclear Reactor Waste Decontamination	Cowan, Strong, Wineche

IV. FACILITIES VISITED

1. Mound Laboratory

(a) Laboratory Buildings

A general air supply of 25,000 cfm was furnished to each laboratory building. The air was precleaned by means of an Air and Refrigeration Company system consisting of one row of concurrent capillary cells* followed by coarse Fiberglas mat droplet eliminators.

Air was exhausted through the hoods in which the radioactive materials were handled. The majority of these hoods were of the dry or glove box type, that is, completely enclosed and provided with rubber gauntlets which extend into the box from arm holes at the front panel. The typical arrangement consisted of two banks of these hoods arranged back to back with a sealed "high risk" service corridor between them. About 30 cfm of room air was allowed to leak into each hood. This air was exhausted through individual CWS No. 6 paper filters in each hood and then to a corridor which was exhaust ventilated by means of large fans located on the floor above. In the corridors the air was passed through a bank of CWS No. 6 filters before reaching the fans whence it was discharged through a 250 foot brick stack situated on high ground. In addition to these high risk hoods and corridors, there were laboratory hoods ventilated in the usual manner and provided with filters when necessary.

The exhaust fans were equipped with modulated damper regulators which permitted zone control in the building. In the

*For descriptions of commercial air cleaning equipment see Chemical Engineer's Handbook, 3rd Ed., McGraw-Hill, 1950.

low risk areas a static pressure of 0.2 inches of water was maintained, whereas in the moderate risk and hot areas static pressures of 0.15 and 0.10 inches of water respectively were maintained. With this arrangement, air leakage was in the direction of potentially hazardous areas where safeguards were more stringent. For instance, entrance to the high risk corridor was limited to a few service personnel dressed in special protective clothing provided with an individual air supply.

The CWS No. 6 filters in each dry box or hood were changed at 2 to 6 month intervals, while the CWS No. 6 filters in the corridors were changed every 6 to 12 months.

In regard to the performance of the overall system, it was stated that the stack effluent was 0.05 of tolerance.

Comments

1. It is felt that the life of all CWS No. 6 filters could be increased with better precleaning of the supplied air, since wet cell washers of the type used are only about 40% efficient for atmospheric dust.
2. It is suggested that dust loading of the air entering the plant as well as that entering the final air cleaning system be determined. This will indicate what proportion of the loading reaching the final filters represents outdoor atmospheric dust. On this basis air precleaning requirements can be estimated.

(b) Incinerator

Appendix II contains a discussion of the incinerators installed or contemplated at the various AEC sites.

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2. Argonne National Laboratory

(a) Machine Shop and Foundry

There was no precleaning of the air supplied to the machining and foundry operations. The beryllium and uranium machining and grinding operations were provided with local exhaust ventilation and air cleaning equipment consisting of an American Air Filter Company (AAF) Type N Rotoclone, heating coils and an AAF Company Electro-cell precipitator.

The smoke and fumes from the burning of uranium were exhausted through Fiberglas filters, while the air exhausted from graphite machining was passed through a Pangborn bag filter.

Comments

1. The efficacy of a Rotoclone as a precleaner for the Electro-cell filter in the uranium and beryllium machining and grinding operations is largely dependent upon the size of the particles in the dust and smoke. Rotoclones of this type are not efficient for particles about 2 microns or less but selection of a wet collector has been predicated on the pyrophoric nature of the material.
2. Fumes from the uranium burning operations may rapidly plug the Fiberglas filters. The life of these filters can be extended by (a) allowing a flocculation period so that the particles can grow in size, and (b) use of a high velocity impingement type filter in front of the Fiberglas.
3. In order to evaluate the Pangborn bag filter at the graphite machining operation, information on particle size and efficiency should be obtained.

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(b) Chemistry Building (under construction)

Plans call for precleaning the air supply to the chemistry building by means of paper or felt filters if necessary. The air will be exhausted through special laboratory hoods developed at Argonne which will be manufactured by the Blickman Company. These have an inlet face velocity of 135 to 170 fpm. Both thermal and mechanical type dampers are under consideration. The back panel of the hood will contain a deeppleated FG 25 filter*. In addition to its function as an air cleaner, this arrangement of filter will maintain a uniform inlet velocity across the open face of the hood. A bank of CWS No. 6 filters situated in the duct upstream from the fan will act as final filters. The filters are supported in the duct by a system of drawbolts and pressure tape which facilitate replacement and minimizes leakage.

A number of gloved boxes with individual FG 25-50 combination filters will be used.

Comments

1. The arrangement of preceding the CWS No. 6 filters with the coarse FG 25 filter is good practice since the latter has a high "holding" capacity and consequently can collect a large quantity of dust before its resistance rises. In addition, it reduces the dust load on the CWS No. 6 and thereby lengthens its useful life.
2. The location of the FG 25 filters at the back panel of the hoods, while advantageous from the standpoint of providing uniform

*Fiberglas filter composed of 3 to 5 micron bonded glass fibers.

hood inlet velocity, may create a hazard to the worker from the radiations originating from the particulate matter collected on the filter. This can be controlled by proper monitoring practices.

3. Los Alamos Scientific Laboratory

- (a) CMR #10 (Chemical and Metallurgical Research Building, under construction)

The air supply will be precleaned by a system consisting of Farr filters, preheaters, straighteners, 30 pound per square inch water sprays, droplet eliminators and another bank of Farr filters.

The exhaust air (27,000 cfm) will be piped to an adjacent filter house where it will pass through a two stage capillary air washer, then to the fans and a 20 foot stack. Each stage of the air washer will consist of one counter-current and one concurrent wet capillary cell followed by a droplet eliminator and dry pad. The so-called capillary cell will be composed of 255 micron glass fibers, 50% to be oriented in a plane perpendicular to the face of the filter. The 20" x 20" x 8" cells will contain 6 or 9 pounds of fiberglass. Each cell is to be wetted by means of 6 hollow cone spray nozzles which will deliver a total of 8.3 gallons of water per minute across the face of the filter.

The dry pad will consist of 10 micron glass fibers packed to an initial density of 0.46 pounds per cubic foot.

Provisions have been made for installing the air cleaners on railroad tracks so that when contaminated the entire assembly can be removed from the filter building by remote handling for

subsequent disposal.

Comments

1. The Farr filters are not good precleaners as they remove only the relatively large particles but allow the fines, which are the ones that plug up the filters, to pass through to the after filters. A system of dry filters of FG 25-50 combination is preferable, and would improve the performance of the after cleaners.
2. Capillary cell washers have only limited use as air cleaners. Exhaustive tests performed at the Harvard University Air Cleaning Laboratory have provided detailed data on performance of these filters. Appendix III summarizes the results of some of these tests.*
3. To insure adequate disposal of exhaust air, the stack on the filter house should be at least 50 feet high.

(b) J-2 Building (Special Analytical Research Building)

The air supply consisting of 70 - 80,000 cfm was pre-cleaned by an American Air Filter Company Electro-Airmat followed by heaters, capillary washers and droplet eliminators.

Air was exhausted through all the laboratory hoods without any cleaning except for some special stainless steel hoods with a water wash panel at the rear, provided for digestion work with perchloric and other acids.

*Information is contained in the paper entitled "Performance of Wet Cell Washers for Various Aerosols" - M.W. First, R. Moschella, L. Silverman, and E. Berly, presented at the American Chemical Society's Symposium on Dispersions in Gases, December 28 and 29, 1950, Baltimore, Maryland.

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Comments

1. The operation of the air precleaning system appeared to be unsatisfactory. The chief complaint was the formation of salts on the filters which eventually passed through and were dispersed throughout the laboratories, interfering considerably with analytical procedures. This condition could be remedied if the spray water were treated to remove hardness and other solids, and the cells kept continuously wetted.

2. All hoods were originally equipped with Minneapolis Honeywell thermal damper controls. Their performance was found to be unsatisfactory with the consequence that practically all of them were removed from operation. The thermal controls on the digestion hoods with water wash had been replaced by manual damper controls which could be made to operate satisfactorily.

(c) D Building (Chemical and Metallurgical Laboratory Research)

The air supplied to this building was cleaned by American Air Filter Company PL-24 filters. Room air was exhausted through chemical hoods provided with individual fans located on the roof. Some of the hoods had Duststop filters. This building is to be replaced by a new one in which it is contemplated cleaning the exhaust air by means of a 1-1/2 stage capillary cell air washer. Supply air will be cleaned by Farr filters.

Comments

See comments under (a) CMR #10 (Chemical and Metallurgical Research Building).

(d) DP West (Production)

The supply air was cleaned by American Air Filter Company

Airmat PL-24 filters. The exhaust air was cleaned by a Precipitron followed by PL-24 filters. A small number of hoods in this building have recently been provided with CWS No. 6 filters.

Comments

1. The exhaust air equipment was installed early in the project. The rated efficiency (85+%) of this method of air cleaning is not adequate for present operations, although performance data indicate that it is operating close to rated values. Under normal conditions the equipment is frequently shut down for maintenance or repairs. The sudden breakdowns emphasize the need for replacing this equipment with some relatively high efficiency air cleaning system such as the combination of FG 25-50 followed by CWS No. 6, or reducing the load* by cleaning at the sources of the highest contamination before passing the air into the main duct system such as has been done by using CWS No. 6 filters.
2. If CWS No. 6 filters are installed, better precleaning of the supply air would lengthen their life. However, to determine more precisely the degree of precleaning required, studies should be made of the concentration of dust in the supply air and discharge air. This will indicate the dust load imposed by the operations in relation to that introduced by the incoming air, and will serve as a basis for determining the degree of precleaning required.

*A 6000 cfm capillary washer pilot research installation of the type proposed for the new D Building is under investigation and will reduce some of the load from highly contaminated ducts.

4. University of California (Berkeley)

General Research Building

The third floor of the General Research Building consisted mainly of laboratory-office units. The general air supply was cleaned through oil bath filters and introduced in the corridors. It was originally intended to exhaust this air through the laboratory hoods by the use of louvres in the doors opening off the corridors. However, the doors as finally installed did not have louvres. Each laboratory-office unit had an individual commercial air conditioner supplying 500 cfm. Since 750 cfm was removed through the hoods in these rooms, makeup air was obtained by leakage through windows and doors.

The hoods in the laboratory-office units were of the canopy hood type, consisting of a metal canopy, suspended from the ceiling, with removable panelyte-covered plywood sides. The filters were 11" x 17" Duststop inserted in the duct above the hood.

Work with highly active materials was performed in gloved boxes ventilated at the rate of 5 to 30 cfm. The exhausted air was cleaned by individual filters of the American Air Filter Company FG 50 type or CWS No. 6 (8" x 8") in a specially designed holder to give maximum filter area.

Comments

1. The penetration of fine atmospheric dust through the comparatively low efficiency Duststop filters precleaning the air entering the gloved boxes will cause plugging of the FG 50

or CWS No. 6 filter, materially shortening service.

2. In general, the use of gloved boxes for highly active materials is to be commended since this reduces the volume of air to be cleaned by the main air cleaning system, facilitates filter maintenance, increases filter life, and reduces air cleaning costs.

3. The holder developed by Garden and Thaxter for a filter consisting of 2 layers of 1/2 inch pleated American Air Filter Company AA-Fiberglas mat is 8" x 8" x 6". This provides a more compact assembly than the 8" x 8" CWS No. 6 filter, and permits the handling of a large volume of air at low resistance and high efficiency.*

5. Knolls Atomic Power Laboratory

(a) Laboratories

All entering air is cleaned by two stage, low voltage electrostatic precipitators; humidifying sprays are available for use if desired. Electrostatic precipitator units are preceded and followed by metal wire roughing filters. A feature of the stack gas cleaning is the use of small treatment units consisting of one or two 24" x 24" x 6" CWS No. 6 filters preceded by FG 25-50 glass fibers. The filter gallery is housed in the floor above the laboratories and work spaces, each room, cave or hood exhausting to its own air filter.

From there the discharged air enters the main duct to a pair of large fans handling almost the entire air volume. From the fans the combined effluent is blown to a 150 foot (approximate)

*The construction details are described in the paper "Air Filters - Simplification of Fine Glass Fiber Mounting", M. D. Thaxter, UCRL-672, April 19, 1950.

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mately) stack and released.

Ventilation to the working spaces is adjusted so that a pressure gradient exists from less contaminated to more contaminated areas. For example, the laboratories are under a slightly more negative pressure than the offices and corridors; caves are under more negative pressure than the laboratories, etc.

A sampling nozzle has been installed near the top of the stack and sample air is conducted through a 3/4 inch pipe containing several 90 elbows down the entire length of the stack and into a shed at the base where it is put through a filter containing HV #70 paper. It was stated that effluent samples were below tolerance when analysed for radioactivity, but there is some question as to how closely the sample they obtained was representative of the average stack effluent because of the long and tortuous sampling line.

(b) Incinerator

A destructor project under investigation at Knolls is described briefly in the appendix.

Comments

1. Data such as particle size generated in various processes and collection efficiency are essential in evaluating the performance of the air cleaning systems.
2. There does not appear to be any convenient way of changing the CWS No. 6 filters and prefilters housed in 2' x 2' x 1' (approximately) plenums in the exhaust ducts without dismantling a considerable length of pipe on each side of the plenum. In

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addition to a high labor charge there appears to be danger of dust exposure to filter maintenance personnel in the course of disassembling and assembling the many sections of contaminated pipe. When removed, contaminated filters are immediately placed in their original pasteboard containers and sealed but there are indications that contaminated filters are being stored in the same filter-gallery areas as clean filters. This is not a desirable practice since it introduces the possibility of using a discarded filter as a replacement. It is suggested that filter housings be redesigned so that rapid replacement of filters may be accomplished with a minimum removal of duct work. One such arrangement is to place the filters in a plywood plenum chamber which could easily be removed from the duct and sealed at each end. This type of mounting is being used successfully at Brookhaven National Laboratory.

6. Hanford Works

(a) Building 314

Dust and fumes from the uranium rod straightening, cutting and melting operations were removed by a 5000 cfm exhaust ventilation system consisting of a fan, cyclone and two Mikropulverizer Hersey type filters in series. While no performance data are available, arrangements are being made to test this equipment. A sampling station has been established adjacent to the air cleaning system and sampling lines lead to various parts of the exhaust system.

Comments

1. It was noted that the sampling lines were long and tortuous with numerous fittings such as reducers, gate valves and elbows. It is quite probable that the samples obtained will not be representative of the conditions within the duct since much of the particulate matter will be removed by centrifugal and impingement forces in the sampling line. It is preferable to use sampling lines of minimum length, straight as possible and with few fittings.
 2. The exhaust fan was on the upstream side of the cyclones and Hersey type filter. This is not a desirable arrangement since any leaks that develop in the equipment would cause the escape of contaminated air into the surroundings. It is preferable to place the fan downstream of the air cleaning equipment so that the fan draws air through the collector, and leakage is inward.
 3. It is questionable whether placing two Hersey units in series will be of much benefit since the filtering medium and velocity is the same in each unit. Particles which succeed in penetrating the first wool felt bag will likely penetrate the second. It is suggested that tests be made to determine filter performance with the units in parallel as this will reduce the filtering velocity in each bag to one half of that with the two units in series.
- (b) Canyon Building 221

The air supply consisted of about 25,000 cfm of air pre-cleaned by wet cell washers followed by droplet eliminators and reheaters. After passing through the cells, air was cleaned in a sand filter and discharged to a 200 foot stack. The sand filter,

a massive concrete structure 110 x 48 x 14 feet deep consisted of numerous layers of varying depths of sand and aggregate ranging from coarse particle sizes ($1\frac{1}{2}$ " to $2\frac{1}{2}$ ") at the bottom to fine sizes (20 to 50 mesh) at the top. Air is drawn up through the filter at a rate of about 4 cfm per square foot. Resistance is $4\frac{1}{2}$ to 5 inches of water and efficiency has been found to range from 99.5 to 99.8%.

Originally the dissolver off-gases were exhausted (at the rate of 100 cfm per dissolver) directly to the stack by steam jets. This procedure was thought to be contributing to the radioactive contamination of the environment around the plant, so arrangements were made to pass the off-gases through the sand filter. Subsequently, it was found that because of the relatively high grain loading of the off-gases (as compared to the cell ventilation air) the sand filter resistance was building up faster than had been previously estimated. Studies were undertaken to find a more satisfactory method of cleaning dissolver off-gases so as to prolong the life of the sand filter. Current plans call for the installation of dry type unit filters on each dissolver.

This is a composite filter developed at Hanford and consists of 5 thicknesses of fiberglass mats of graded fiber size, packing density and depth with a total filtering depth of approximately 21 inches.

The I^{131} in the dissolver off-gases is to be removed by a silver nitrate reactor consisting of a tower packed with ceramic saddles coated with silver nitrate. Preceding the silver reactor are heaters for conversion of all iodine in the air stream to the

gaseous state. A heater, silver reactor and type 115-K filter are to be installed atop each dissolver, replacing the water scrubber. Nitrous oxides generated during the first steps of the dissolving operation (to remove the aluminum sheath) are to be by-passed directly to the stack.

Comments

1. The principle of the composite filter is sound since in effect it represents a variable gradient unit having a relatively coarse medium followed by a high efficiency material. This not only provides a large volume for storage of collected particles, but also permits the removal of larger particles by the coarser layers and reduces the load on the final filter which increases overall filter life.
2. To determine the expected life of the composite type filter, laboratory tests were made using methylene blue smoke. Data were obtained on filter pressure drop versus weight of collected smoke. These figures were extrapolated to predict the rise in resistance that would occur in the case of atmospheric dust. This procedure is open to question since the particle size distribution of atmospheric dust differs considerably from that of methylene blue smoke. Obviously the large particles of atmospheric air would not produce as high a pressure drop as the finer particles in methylene blue smoke. Filter life tests are usually reliable only if performed with the dust to be collected.

7. Ames Laboratory

(a) Metallurgy Building

Numerous dust and fume producing operations were hooded and exhaust-ventilated by individual blowers located on the roof. The exhaust air from the thorium and zirconium operations were cleaned by a Type N Rotoclone. The HF reduction process was exhaust-ventilated with 3000 cfm of air and cleaned by means of a Type N Rotoclone.

Comments

1. As stated previously, Rotoclones are not efficient for removing fine dust and fumes.
2. It was noted that each blower exhaust stack was capped with a cone shaped nozzle. While no inherent advantage can be seen in such a design, it must be pointed out that convergent nozzles of this type increase outlet losses which in turn increase blower power consumption.

(b) Research Building

The fumes from the uranium burning operations were passed through a 5550 cfm Rotoclone having a pressure drop of 6 inches.

High level radiochemical work will be done in a cave connected to an air supply precleaned by two rows of Farr filters in series. 9000 cfm of exhaust air will pass through a viscous filter, followed by American Air Filter deep pocket and CWS No. 6 filters.

Comments

1. The comparative low efficiency of Rotoclones for collection of fine dust and fumes has been discussed previously.

2. Better precleaning of cave supply air is recommended since Farr filters are efficient only for the collection of large particles. The penetration of fines serves to accelerate the plugging of the filters for the exhaust air. Filters comparable to FG 25-50 are preferable.

3. Better exhaust air cleaning could be achieved by eliminating the viscous filter and permitting FG 25-50 combination and CWS No. 6 filters to carry the effluent load. The savings could be applied to better precleaning for the canyon air.

8. Oak Ridge National Laboratory

(a) Buildings 706C and 706D

The air to these buildings was not precleaned. Exhaust air from dissolver reaction vessels (200 cfm) passed through a 75 KV stainless steel Cottrell precipitator equipped with automatic or remote controlled water washing sprays. Air from the electrostatic precipitator then passed through a reheater to raise the air temperature well above the dew point, AAF FG 25-50 and CWS No. 6 filters and was discharged through a 250 foot stack.

The air exhausted from the cells (1600 cfm) was cleaned by means of a 9 KV Trion precipitator backed up by FG 25-50 and CWS No. 6 filters and discharged to the same stack.

Air from the general room and hoods was discharged directly to the stack.

Comments

1. The practice of handling cell and reactor exhaust air separately is to be commended. Splitting of the systems into high, medium and low activity air streams lends itself to efficient and economical air cleaning procedures.

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2. Air treatment by 60-100 KV, automatic cleaning, stainless steel electric precipitators while highly efficient, requires a large capital outlay for equipment. Moreover, because of the possibility of electrical breakdowns, they should be followed by some form of dry filter. Therefore, it is suggested that a thorough review of this method of air cleaning be made to determine whether the expense (\$100,000 for equipment to treat 2,000 cfm) is justified and whether some other form of cleaning (such as FG 25-50 followed by CWS No. 6) would yield equally efficient results with advantages in cost and maintenance.

(b) Building 706 HB (Semiworks)

This building contained eight cells for unit operations on a pilot plant scale. Untreated air was supplied to each of these cells at the rate of 7500 cfm. The air was exhausted directly to the outside through roof vents.

Comments

A survey should be made to find out whether the operations in this building generate radioactive or other toxic gases.

(c) Building 706A

Air exhausted through chemical hoods in this building is not treated. This building is to be replaced by the new Research Building which will be equipped with a 120,000 cfm air conditioning system.

(d) Physics of Solids Building (under construction)

This building will contain a cell for housing a complete machine shop operated by remote control. Each machine will have individual local exhaust ventilation.

Oak Ridge type hoods will be provided throughout the building for normal work. High and low vacuum lines in these hoods will be used for removing toxic gases, dust and fumes to the central electrostatic type air cleaner mentioned in previous sections (Buildings 706C and 706D). Work with radioactive material will be performed in gloved boxes situated in hoods. Inlet air velocity into the hoods will be about 50 fpm through a streamlined face opening.

(e) Nuclear Reactor Ventilation

The nuclear reactor was cooled by 120,000 cfm of air pre-cleaned by AAF PL-24 filter units loaded with 3/32 inch Type G filter medium.

On leaving the pile, the air passed through the filter house to the fans at an initial static pressure of 39 inches and then to the stack. The filter house contained preliminary and final filters. The former were composed of $\frac{1}{2}$ inch thickness of FG 25 and FG 50 set in deep-pocket filter holders operating at an initial pressure drop of 1 inch of water at 20 fpm face velocity. The final filters were CWS No. 6 units (24" x 24" x 6" set in wooden frames) with an effective filtering area of 150 square feet and an initial resistance of 1 inch of water for a filtering velocity of approximately 4 fpm. The overall initial pressure drop across the filter house was 3.5 inches of H_2O . The installation was designed for a resistance increase to 8 inches before the CWS No. 6 filters must be replaced. The final filters are secured by an air seal to prevent leakage around the filter frame. One fourth of the preliminary filters are changed every six months.

The overall efficiency for this combination of preliminary and final filters is stated to be 85-90%. Usually this arrangement of filters is above 99% for inert and radioactive dusts, however the performance figure is apparently reduced when handling short-lived radioactive gases which have daughter products appearing as solids after the filter.

This installation is reported to have reduced the particle problem in this area very substantially.

Comments

1. The arrangement of FG 25-50 followed by CWS No. 6 on the exhaust air is highly recommended.

A significantly large proportion of the load reaching the after-filters represents outdoor atmospheric dust penetrating through the relatively inefficient Type G Airmat medium in the pre-filters. Because of the high material and replacement labor cost of the after-filters (especially at this particular installation), the use of a highly efficient precleaner such as the FG 25-50 combination would be economically justified by the savings affected by longer after-filter life. Because the precleaning filters would be radioactively inert when loaded, no special procedures would be required during their replacement operation.

(f) Machine Shop (Y-12 Area)

Air cleaning system for the beryllium machining operations consists of an inertial separator followed by a high efficiency filter. Duct samples and atmospheric samples in the vicinity of the shop indicate that adequate cleaning is being accomplished.

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Comments

1. It was noted that the blower had been placed before the final filter so that filtration took place under positive pressure. This made it essential that the filter housing be maintained in an air tight condition -- a difficult undertaking. The personnel in charge were aware of this difficulty and were taking adequate measures to control it. Nevertheless, it should be noted that the preferred practice is to have the entire dust cleaning system under negative pressure so that leaks will be inward. This materially simplifies maintenance and monitoring procedures.

9. Westinghouse Atomic Power Division

The design, production and testing of power reactor components and auxiliary equipment was performed in two locations -- the hangars and the Main Building.

(a) Hangars

Machining of uranium, beryllium, zirconium and graphite were done in shops located in the two hangars. Exhaust air from all operations passed through Type N Rotoclones, some of which discharged to 20 foot stacks, whose tops were only 3 feet above the adjacent buildings.

(b) Main Building

Dry boxes for special work and specially designed hoods were used in the machine shop and on grinding and rolling mills. Beryllium, uranium, zirconium, graphite and fluoride flux dust and fumes were exhausted through Type N Rotoclones. This type of air cleaner was selected because a wet system was desired for

collection of acid mist as well as particulate matter, and because of the absence of advance information on the nature of operations to be performed.

The hot laboratory (near completion) consisted of five cells, each supplied with 500 cfm of exhaust ventilation and connected to a Type N Rotoclone. When cell doors were opened a separate exhaust system (2500 cfm per cell) was automatically started. The system was actuated by static pressure controls on the doors, and was so arranged that not more than 2 doors could be opened at a time. The Rotoclones discharged to a 6500 cfm Westinghouse two stage Precipitron with operating voltages of 13 and 6.5 KV on the 1st and 2nd stages, respectively. In one cell the Rotoclone was followed by a filter containing two layers 1 inch thick of FG 50 medium.

One cell, for handling enriched uranium, was provided with a 500 cfm blower exhausting air through an "accountability" filter. This consisted of FG 50 medium operated at a face velocity of 100 fpm. Uranium can be reclaimed by removing the filter and extracting the glass fibers with acid.

In shop No. 25 a Type N Rotoclone preceded a dry filter handling 5000 cfm. Hoods were of simple construction with exhaust blowers mounted at the top.

In the metallurgy wing there were five Type N Rotoclones; two size No. 8, two size No. 2-1/2, and one size No. 4. These exhaust and clean air from miscellaneous grinding, fusing, welding

*An accountability filter is a device to retain air borne particulate matter for evaluation of process loss.

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and cutting operations on a variety of materials.

Comments

1. If the Rotoclones in the metallurgy wing are to be used on very toxic materials, further cleaning of the effluent will be necessary.

10. Mallinckrodt Chemical Company

(a) Production of Uranium Metal and Oxide

There were 11 Hersey type bag filter units with a total capacity of over 61,000 cfm. Most of the units were manufactured by the Mikropulverizer Company and had a 36 inch bag. One unit was made by the Day Company and used small 6 inch bags. These handled black oxides, orange oxides, green salts and their mixtures, pitchblende ore dust, and lime dust. At the present time efficiency data obtained on all collectors indicates well over 99.9% removal on a mass basis. Particle size data are lacking, but plans are being made to have this information collected by the plant industrial hygienist.

It was learned that originally many of those operations were exhausted through Pangborn collectors, but these had been replaced by the Hersey bag filters which were giving good service on all but one type of black oxide, that produced by graphite crucible burning. This dust, of an estimated particle size of 1 micron, seeped through the felt medium. The cause of this sifting was not known but may be an electrostatic charge phenomenon.

One operation created a dust which could not be collected dry because of its tendency to cake. This operation will be

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equipped with a 2000 cfm system consisting of a Type N Rotoclone followed by a wet cell washer. A Sly bag filter was used for collecting lime dust.

Previously a Type W Rotoclone was tried on brown oxide, and a Type D Rotoclone was tried on the vacuum furnace black oxide. Neither of these units gave satisfactory performance. Another Sly unit is used on a green salt operation.

Some dust-tube type collectors on Spencer and Hoffman vacuum cleaner systems were still in use and appeared to be giving satisfactory results. While their cleaning performances were generally comparable, the Hoffman seemed to be the better built vacuum cleaner and gave fewer maintenance problems.

(b) Laboratory

Air was precleaned by means of a AAF Company multi-duty viscous filter followed by an Electromatic filter. Some precleaning was also done through an Owens-Corning Duststop filter.

The plant industrial hygienist plans to establish a testing schedule for all air cleaning equipment.

Comments

In addition to obtaining weight efficiency data, information on particle size of materials emanating from various operations would be very useful.

11. Brookhaven National Laboratory

(a) Hot Laboratory

In the cold areas the air exhausted through hoods was not filtered. In semi-hot laboratories hood air was exhausted through drain lines equipped with Raschig ring packed scrubbers to remove acid fume. Final cleaning was done by Fiberglas followed by CWS No. 6 paper.

On the hot hoods CWS No. 6 units consisting of 2 - 24" x 48" x 6" (600 cfm each) wooden frame units were mounted on each side in a wooden plenum chamber. Inlet and exit openings were on opposite ends of this chamber. By sealing the ends all contamination was kept inside when the unit was to be removed. This plenum was mounted inside a metal housing and access was provided through bolted ends.

In the works laboratory (a large room), exhaust air was cleaned by CWS No. 6 filters and discharged through a booster fan to the big stack, which exhausted air from the reactor. The stack was discharging about 320,000 cubic feet of air per minute: 20,000 cubic feet of this was from the hot laboratory.

The rooms were maintained at a slight negative pressure at all times. Roof fans had excess capacity to take care of changes in the works laboratory room static pressure.

Air from decontamination cells was discharged through a roughing Fiberglas filter mounted in an AAF Type G dry filter frame, and through CWS No. 6 paper. There were also three small hot cells exhausting 50 cfm through CWS No. 6 paper filters.

In the waste room (where waste is held for monitoring),

air was exhausted from the cold points through this hot area and then through CWS No. 6 filters and to the stack.

For special operations in the works laboratory air passed through scrubbing towers which could be arranged four in series, two in parallel or singly, as needed. These were special scrubbing towers designed by the H. K. Ferguson Company.

The basement of the hot laboratory building was provided with the same type of installation as the semi-hot laboratories. The CWS units (24 x 48 x 6 inch size) handled 600 cubic feet of air or a total of 1200 cfm in each plenum.

(b) Nuclear Reactor

It was learned that the reactor had operated at a power level as high as 30 megawatts, resulting in exhaust air temperatures varying from 300 to 600 F.

The pile air precleaning system, which was installed after the original design, consisted of FG 25-50 medium in deep-pocket filter holders. The glass fiber was set vertically rather than horizontally (as in the standard AAF Company deep pocket filter). The clean filter resistance was about 0.08 inches of water and the filter face velocity was greater than the recommended value (probably 100 fpm).

The blowers for the reactor stack consisted of five 1500 horsepower motors moving 300,000 cubic feet of air per minute against a total resistance of 63 inches of water. Exhaust filtration was provided through a Dollinger glass cloth filter which is recognized as not being of much value for particles less than approximately 5 microns. However, the problem of slug

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ruptures was not considered serious because of improved reactor design which provided helium sealing of slugs. A change of pressure would result in the expansion of the chamber and it would thus be possible to detect a swollen slug before rupture and remove it from the pile.

Currently under advisement is a program for checking stack efficiency.

(c) Waste Decontamination

A study was being made of filtering radioactive steam. Good results had been obtained with FG 25 media which showed a decontamination factor of 10^7 to 10^8 . It had been found that resistance did not change and that neither super-heated steam nor return refluxing were advantageous. It was observed that condensing steam tended to clean the filter.

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V. APPENDIX I.

TABLE II

Air Cleaning Facilities at AEC Sites Visited

	LABORATORY BUILDINGS	INCINERATOR PILOT PLANT
1. MOUND LABORATORY	<u>AIR SUPPLY</u> - 250,000 CFM Wet Cell washers consisting of 2 rows of concurrent capillary cells followed by fiberglass droplet eliminators <u>AIR EXHAUST</u> Through heads having individual CWS No. 6 filters, into high risk corridor also having CWS No. 6 filters, to 200' stacks. Filters at hoods changed at 2 to 6 month intervals. Filters in corridors changed at 6 to 12 month intervals. Zone control maintains: 0.2" H ₂ O static pressure in low risk area 0.15" H ₂ O static pressure in moderate risk area 0.10" H ₂ O static pressure in high risk area Overall performance: Stack effluent reported to be 0.05 of tolerance	Oxygen-enriched incinerator followed by: rough washer Nash pump steam ejector expansion chamber Peese-Anthony scrubber CWS No. 6 Filter Performance - 10 ⁷ decontamination factor
	MACHINE SHOP AND FOUNDRY	CHEMISTRY BUILDING (under construction)
2. ARGONNE NATIONAL LABORATORY	<u>AIR EXHAUST</u> Beryllium and UO ₂ machining and grinding; Type N Retoclone heating coils and MF Electro-cell precipitator Burning of Uranium Fiberglass filters Graphite Machining; Pangborn bag filter	<u>AIR SUPPLY</u> To be cleaned by paper or felt filters if necessary <u>AIR EXHAUST</u> through hoods having deep pleated FG filters situated at back panel. Final filters to be CWS No. 6

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Table II—Air Cleaning Facilities at AEC Sites Visited

	CWR No. 10 (under construction)	J-2 Buildings (laboratories)	D Building	DP-West	PILOT DESTRUCTOR (under construction)
3. LOS ALAMOS	<u>AIR SUPPLY</u> Farrs preheaters, straighteners 30# sprays eliminators, Farrs <u>AIR EXHAUST</u> —27 000 CFM Two stage capillary air washers and 20' stack	<u>AIR SUPPLY</u> —75,000 CFM Electro-Airmat, heaters, capillary air washer, droplet eliminator <u>AIR EXHAUST</u> —Through hoods without cleaning. Special hoods had water wash panel	<u>AIR SUPPLY</u> MF PL-24 filters <u>AIR EXHAUST</u> Through hoods with individual blowers at roof. Some equipped with duststop filters	<u>AIR SUPPLY</u> MF PL-24 filters <u>AIR EXHAUST</u> Precipitron followed by PL-24 filters. CWS No. 6 at some hoods	100#/HR <u>AIR EXHAUST</u> —2000 CFM Dry cyclone, Venturi scrubber, Peese-Anthony, and FG 25-50
	GENERAL RESEARCH BUILDING				
4. UNIVERSITY OF CALIFORNIA BERKELEY	<u>AIR SUPPLY</u> General supply to corridors, Unit air conditioning in each lab office room—500 CFM <u>AIR EXHAUST</u> 750 CFM per room through hoods with Duststop filter 5 to 30 CFM through each gloved box equipped with MF 25-50 or CWS No. 6				
	LABORATORIES	INCINERATOR			
5. KNOLLS	<u>AIR SUPPLY</u> Cleaned by metal wire filters followed by electrostatic precipitators <u>AIR EXHAUST</u> FG 25-50 and CWS No. 6 and 150' stack	Incineration with pure oxygen followed by condenser sulphur burner steam chamber CO ₂ scrubber Pease-Anthony scrubber reheater FG 25-50 CWS No. 6			
	BUILDING 314	BUILDING 221			
6. HANFORD	<u>AIR EXHAUST</u> —5000 CFM Cyclones, 2 Hersey type filters in series	<u>AIR SUPPLY</u> —25,000 CFM Wet cell washers and droplet eliminators <u>AIR EXHAUST</u> Sand filters and 200' stack Filter perform. —99.5 to 99.8% to be replaced by composite FG filter			

TABLE II—Air Cleaning Facilities at AEC Sites Visited

	METALLURGY BUILDING	RESEARCH BUILDING				
7. AMES LABORATORY	<u>AIR EXHAUST</u> Thorium and Zirconium operations: Type N recticlene HF reduction: 3000 CFM Type N recticlene	<u>AIR SUPPLY</u> CAVE: Precleaning by 2 rows of Farr filters in series <u>AIR EXHAUST</u> CAVE: 9000 CFM viscous filters, followed by AAF deep pocket and CWS No. 6 filters <u>URANIUM BURNING</u> : 5550 CFM Type N recticlene				
	706 C and D	REACTOR	706 HB (semiworks)	706 A	PHYSICS OF SOLIUS (under construction)	MACHINE SHOP (Y-12)
8. OAK RIDGE (X-10)	<u>AIR SUPPLY</u> —No cleaning <u>AIR EXHAUST</u> Reactor Vessels: 200 CFM 75 KV Cottrell with water sprays, heater, AAF FG 25-50, CWS No. 6 and 20' stack <u>CELLS</u> : —1600 CFM 9 KV Trion precipitator FG 25-50, CWS No. 6, 250' stack <u>HOODS</u> : To stack directly	<u>AIR SUPPLY</u> —120,000 CFM Precleaned by AAF PL-24 filters <u>AIR EXHAUST</u> —120,000 CFM AAF deep pocket frames Holding FG 25-50, CWS No. 6 Stack	8—Unit Operation Cells <u>AIR SUPPLY</u> —7500 CFM/ Cell. No cleaning <u>AIR EXHAUST</u> Directly to roof vents	<u>AIR EXHAUST</u> —Through hoods. No cleaning	This building will contain a cell for housing a machine shop. INDIVIDUAL EXHAUST VENTILATION HOODS ON EACH MACHINE	<u>AIR EXHAUST</u> Beryllium Machining inertial cleaner followed by high efficiency filter
	HANGARS	MAIN BUILDING				
9. WESTINGHOUSE ATOMIC POWER DIVISION	<u>EXHAUST AIR</u> Uranium, beryllium, zirconium and graphite burning operation: Type N recticlene	<u>EXHAUST AIR</u> U, Be and zirconium, graphite and fluoride operations: Type N recticlene Hot Laboratory: Type N recticlenes followed by 6500 CFM precipitation or FG 50 Enriched uranium cell: 500 CFM exhausted through FG 50 accountability filter				

TABLE II—Air Cleaning Facilities at AEC Sites Visited

	URANIUM PRODUCTION	LABORATORY
10. MALLINCKRODT	<u>EXHAUST AIR</u> Brown, orange, and black oxides: II Hersey type filters —6000 CFM Silv bag filters for line dust and green salt operation. Spencer and Hoffman vacuum cleaners	<u>AIR SUPPLY</u> Precleaned by AAF viscous filter, followed by Electromatic filter, or Owen's Corning Duststop filter
	HOT LABORATORY	NUCLEAR REACTOR
11. BROOKHAVEN NATIONAL LABORATORY	<u>AIR EXHAUST</u> <u>Semi-hot hoods:</u> air cleaned by Raschig ring scrubbing towers Final cleaning—fiberglass followed by CWS No. 6 <u>Hot hoods:</u> air cleaned by CWS No. 6 filters mounted in special plarum chamber <u>Works laboratory:</u> air cleaned by CWS No. 6 filters to large stack—in special operations scrubbing towers designed by H. K. Ferguson Co. are used <u>Decontamination cells:</u> air cleaned by fiberglass followed by CWS No. 6 <u>Hot cells and waste room:</u> air cleaned by CWS No. 6 <u>Waste decontamination:</u> decontamination of steam Cleaning done by FG 25 filter	<u>AIR SUPPLY</u> —300,000 CFM Precleaned by FG 25-50 <u>AIR EXHAUST</u> Air cleaned by Dellinger glass cloth type G filter

APPENDIX II

Incineration of Radioactive Solid Wastes

During 1950 four AEC sites were engaged in activities directed toward the development of suitable methods for concentrating combustible solid radioactive wastes by means of incineration. Estimates prepared by A. D. Little, Inc., for Argonne National Laboratory indicate that the cost of prolonged storage of radioactive contaminated wastes is close to \$7.00 per cubic foot. Volume reduction by incineration is estimated to average 94%, resulting in a considerable financial saving to the Commission, over and above the added cost of treatment.

The disposal of solid wastes by incineration may be conveniently divided into three operations: (1) burning of the wastes (2) disposal of the ash and (3) cleaning of the combustion gases. This report will be concerned only with the last phase.

Acceptable activity-levels for radioactive stack effluents have not been established, and there is considerable diversity of opinion as to what constitutes adequate gas-cleaning. In some instances breathing-level tolerances have been specified and in others "as good decontamination as is economically justified". The former standard is not supported by good practice procedures commonly found in industry (where values in the range of 10 to 30 times room tolerance may be an adequate standard), and the latter standard is inadequate for proper application of sound engineering practices.

Location of the incinerator projects and progress to date are as follows:

- (1) Argonne National Laboratory. Design for proposed installa-

tion prepared by A. D. Little, Inc. Construction is in the "drawing board" stage. No pilot plant studies will precede construction of the full scale installation. Estimated completion date: July, 1951.

(2) Los Alamos. Full scale destructor plant designed by the Ralph M. Parsons Company now under construction. No pilot plant studies preceded construction of this equipment. Estimated completion date: January, 1951.

(3) Knolls Atomic Power Laboratories. Full scale destructor put into operation about July, 1950. Preliminary tests being conducted on non-radioactive materials.

(4) Mound Laboratory. Experimental pilot-plant under test with radioactive wastes. Full scale plant under consideration: completion date unknown.

The gas cleaning systems in operation or contemplated for the four destructor installations are as follows:

1. Argonne National Laboratory

Incinerator is designed to handle 125 pounds of waste per hour and air cleaning system to handle approximately 200 cfm of furnace and recycle gas at S.T.P. in the following stages:

(a) a ten plate, radial vaned Schreier-Bartolucci centrifugal gas washer (b) a 6 x 2.5 inch Venturi scrubber followed by a 4 plate (baffled) Peabody gas scrubber, and (c) an AEC, or CWS No. 6 filter preceded by a reheater.

Overall predicted efficiency is 99.999+% and resistance estimated to be 30 inches of water, or greater. This system follows the principle of successive stages of increasingly

efficient air cleaning devices. The Venturi scrubber introduces a high resistance element (20 inches of water, approximately) into the system and necessitates the use of a preceding wet stage (Schreier-Bartolucci washer) to precool the gases for best results.

2. Los Alamos

Incinerator is designed to handle approximately 200 pounds of solids per hour and to use 2800 cfm of air at S.T.P. Combustion gases leaving the furnace will be about 10,000 cfm at 1500°F. Air Cleaning system is composed of the following elements in the order named: (a) dry cyclone to remove the bulk of coarse material (b) Venturi scrubber and Pease-Anthony washer (a centrifugal washer to be operated dry) and (c) FG 25-50 glass fibers at a filtering velocity of 15 fpm, the FG 25 acting as a roughing filter for the FG 50 medium. This system is composed of increasingly fine air cleaning devices utilizing three different cleaning principles (inertia, wet scrubbing and filtration). It is a high resistance system due, principally, to the Venturi scrubber. Some question exists as to the efficiency of the Venturi scrubber on very hot gases, since the cooling effect of the water-injection may greatly decrease velocity through the Venturi throat (a critical factor in the operation of this device). Whether or not the FG 25-50 fiber glass filters will give sufficient decontamination is not known, but facilities have been provided for following them with AEC or CWS No. 6 filters if necessary, and the addition of a reheater to dry the gases. If the fiber

glass filters give the desired decontamination (to be determined by experiment), reheating will not be needed since their performance does not appear to be adversely affected by moist gases.

3. Knolls Atomic Power Laboratories

The Knolls incinerator is designed to burn wastes in an atmosphere of pure oxygen fed at the rate of 7 cfm (S.T.P.) and to handle about 20 pounds of solid waste per hour. The resulting off-gases constitute a very small volume and the air cleaning devices are necessarily in miniature. The air cleaning system seen in operation in August, 1950 consisted of the following devices in the order named: (a) water-jacketed condensation column to cool and partially dehydrate the combustion gases (b) sulphur burner to complete the chemical combination of oxygen (c) agglomeration with steam (d) absorption of CO_2 and removal of water droplets in a diethanolamine Raschig ring scrubbing tower (oxygen interferes with CO_2 absorption by this process, necessitating the sulphur burner noted above) (e) Pease-Anthony centrifugal washer (f) FG 25-50 glass fiber media preceded by a reheater, and (g) CWS No. 6 filter.

When observed, the static pressure in the furnace ranged from about 20 to -20 inches of water, indicating poorly controlled burning, and the sulphur burner had not yet been put into operation. Little if any condensate could be observed flowing from the initial water jacketed cooling chamber. After about one hour of burning the packed absorption tower was observed to become fouled and plugged with combustion products (tar, flyash,

etc.). In general the entire system appeared to be completely unsatisfactory. It was subsequently learned (October, 1950) that the CO₂ absorption process would be abandoned and that the rest of the system would be re-designed on a rational, step-wise basis as indicated by controlled operational tests. In the event gas absorption processes should become desirable for any reason, they should be placed after the final particulate cleaning stage to avoid plugging of the column by solid wastes.

It is felt that re-examination and re-designing of this incinerator and its gas cleaning system was a wise decision.

4. Mound Laboratories

An experimental pilot plant capable of burning about 15 pounds of solids per hour and to utilize about 20 cfm of air at S.T.P. has been under test and development for about two years. The air cleaning system consists of the following equipment in the order named: (a) spray washing tower (b) Pease-Anthony wet cyclone washer (c) Nash pump (acts as air pump and air scrubber) (d) steam nozzles and expansion chamber for droplet cloud formation (e) a second Pease-Anthony wet washer and (f) a CWS No. 6 filter. A decontamination factor of 10⁹ has been reported for this system. The air cleaning system appears to be extraordinarily complex and costly in operation. Approximately 10 H.P. are used to run the Nash pump and 250 to 300 pounds of 90 psi super-heated steam and 1262 gallons of water are required for treatment of the gases from 20 pounds of solid waste. All of this water must eventually be decontaminated in a liquid waste disposal unit. Since overall gas cleaning efficiency has been calculated from analyses of wash water contamination and no

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overall material balances have been attempted, the reported efficiencies should be regarded as estimates.

Comment

There is a choice of methods and a large number of devices available for the cleaning of radioactive incinerator gases. In general, a satisfactory effluent may be achieved by three gas cleaning stages in the following order: (1) rough cleaning and cooling of the combustion gases with a wet type of gas cleaner (for example, a wet centrifugal scrubber capable of removing 85-95% of the particulate load by weight)(2) an efficient fibrous deep-bed filter, such as the fiber glass FG 25 and 50 type, preceded by a reheater to raise the temperature of the gases leaving the wet scrubber well above the dew point. (At a filtering velocity of 25 fpm, one inch of FG 50 is capable of lowering the solid content of the gases by over 90%)(3) An efficient cellulose-asbestos paper of the AEC or CWS No. 6 type (capable of removing 99.99+% of particles less than one micron in size at filtering velocities of 5 fpm or less).

Such a system would have an overall efficiency in excess of 99.999%; This degree of decontamination would be adequate, in most instances, for successful operation of full scale incinerators handling reasonably large volumes of air. It may be noted that the combustion gases are treated by progressively more efficient cleaning devices for maximum effectiveness. It is not meant to imply that the above procedures and devices and the only ones that may be successfully employed for this work, but merely to illustrate an adequate but simple system

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that will operate at a relatively low resistance (4-8 inches of water) and cost. It is anticipated that contaminated filters will be concentrated in the incinerator and the slurry from the wet so rubber disposed of by liquid waste decontamination processes already in operation. In this connection it might be desirable to substitute cellulose or animal fibers (cotton, or wool etc.) for glass as prefilters.

The diversity of air cleaning methods and equipment at the four sites engaged in solid waste destructor programs can result in great benefit to the Commission if adequate appraisal of their performance under actual operating conditions is made. In this connection, the principal recommendation to be made is that adequate, controlled studies be carried out as rapidly as possible so that future design and modification of solid waste destructors may be based on this experience.

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APPENDIX III

Performance of Wet Cell Washers

Table III

Efficiency of Two Standard Capillary Washer Cells in Series
(Countercurrent and Concurrent Sprays)

Aerosol	MassMedian diam. (microns)	Geometric Mean Size by Count (microns)	Inlet Loading (mg/M ³)	Efficiency (% by weight)
Uranium trioxide microspheres	0.8	0.2	0.015-0.130	17
Soluble copper sulfate microspheres	2.5	0.7	70-115	32
Insoluble talc	2.3	1.3	2.5-4.5	68
Atmospheric dust	--	0.5	0.2-0.4	21 (Stain effc)

Water rate - 9 gals. per min. per 20" x 20" x 8" cell
Filtering velocity - 216 feet per min.

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TABLE IV

Efficiency of 3 Capillary Cells and Two Dry Pads in Series
(arrangement: countercurrent sprayed wet cell, con-
current wet cell, dry pad concurrent wet cell,
dry pad)

Aerosol	Mass.Median diam. (microns)	Geometric Mean Size by Count (microns)	Inlet Loading (mg/M ³)	% Efficiency
Uranium trioxide microspheres	0.8	0.2	0.015-0.130	82 (weight efficiency)
Copper sulfate microspheres	2.5	0.7	2.5-3.5	88.5 (weight efficiency)
Atmospheric dust	--	0.5	0.2-0.4	29 (stain efficiency)

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