AUG 24 1967

MASTER

OAK RIDGE NATIONAL LABORATORY
operated by
UNION CARBIDE CORPORATION
NUCLEAR DIVISION
for the
U.S. ATOMIC ENERGY COMMISSION

ORNL - TM - 1940 (Part 1)

50

SELECTED ABSTRACTS OF NON-U. S. LITERATURE ON PRODUCTION
AND INDUSTRIAL USES OF RADIOISOTOPES
(From NSA January-June 1967)

NOTICE This document contains information of a preliminary nature and was prepared primarily for internal use at the Oak Ridge National Laboratory. It is subject to revision or correction and therefore does not represent a final report.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

- A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or
- B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

Contract No. W-7405-eng-26

CISTI PRICES

ISOTOPES INFORMATION CENTER

H.Q. \$ 3.00, MH .65

SELECTED ABSTRACTS OF NON-U.S. LITERATURE ON PRODUCTION
AND INDUSTRIAL USES OF RADIOISOTOPES

(From NSA January-June 1967)

Martha Gerrard and P. S. Baker

AUGUST 1967

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee
operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:
A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or
B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.
As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

CONTENTS

	Page
Abstract	v
Introduction	v
General	1
Isotope Production and Development	3
Production	3
Targets	4
Separation	4
Generators	10
Labeled Materials	10
Isotope Technology Development	11
Activation Analysis	11
Gamma	13
Charged Particles	14
Neutron	15
Separation	21
Isotope Dilution	23
Radiation Absorptiometry	23
Gages	24
Ionization	25
Moisture	26
Moisture and Density	27
Density	27
Thickness	28
Level	30
Hardness	30
Radiography	30
Tracers	31
Autoradiography	34
Radiometric Analysis	35
Commercial Products Preservation	36
Medical Supplies	36
Food	36
Wholesomeness	38
Grain	39
Root Crops	39
Fruit	39
Vegetables	39
Milk and Eggs	40
Meat and Poultry	40
Seafood	41
Hides	41

	Page
Process Radiation Development	42
Polymerization	42
Graft	44
Cross-linking	45
Copolymerization	46
Ionic	47
Solvents	48
Solid State	48
Liquid State	50
Foamed Bodies	50
Porous Materials	51
Wood Polymers	51
Vulcanization	52
Materials Modification	52
Chemicals Manufacture	52
NH ₃ Synthesis	53
HCN Synthesis	53
Oxidation	54
Chlorination	54
Catalysis	55
Source and Irradiator Development	55
Irradiation Facilities	56
Power Sources	57
Small Sources	57
Safety	59
Manuals	60
Laws	60
Transportation	60
Structures	61
Handling Devices	61
Miscellaneous	62

SELECTED ABSTRACTS OF NON-U.S. LITERATURE ON PRODUCTION
AND INDUSTRIAL USES OF RADIOISOTOPES

(From NSA January-June 1967)

Martha Gerrard and P. S. Baker

ABSTRACT

More than 750 abstracts of non-U.S. publications on production and use of radioisotopes and radiation, selected from the January-June 1967 issues of Nuclear Science Abstracts, are presented.

INTRODUCTION

Abstracts of selected publications from outside the U.S. on production and industrial uses of radioisotopes are assembled here. Selections were limited to those of industrial interest, the word "industrial" being interpreted occasionally to mean work still under development but with potential industrial applications. The arrangement of the abstracts is, in general, like that used in Isotopes and Radiation Technology, a quarterly Technical Progress Review of which this bibliography is a by-product. Within each section abstracts are grouped roughly according to subject; conference proceedings are generally kept together. No indexes are provided because the document is intended for current awareness only.

The abstracts were selected from Nuclear Science Abstracts, Vol. 21, January-June issues.

GENERAL

3220 ECONOMICS OF THE INDUSTRIAL APPLICATION OF ISOTOPES IN HUNGARY AND ELSEWHERE. Abelovszky, Laszlo. Atomtech. Tsjek., 9: 181-90(1966). (In Hungarian).

Data have been collected for the last 3 years at the IAEA to provide a clear picture on the business aspects of the industrial application of isotopes. In view of the centralized control over the supply of isotopes in most countries, the purely technical questions were satisfactorily answered, but the economic and business side of the problem was treated in a cursory manner. The level of use of isotopic techniques appears to be directly related to the degree of technical development and sophistication of the country in question. This study was used, together with pertinent Polish and Soviet reports, to compare the application of isotopes in Hungary to that of the more strongly industrialized countries. The chief difficulty lay in the absence of a general reference money for the Eastern European countries; because of the lack of convertibility, the U. S. dollar was used for comparison. Savings arising from the use of isotopic materials and techniques were estimated in the following areas: measurement technology, flow detection, ionization (radiation technology) and tracer techniques. Current research seems to be concentrated in the fields of nuclear geophysics, automatic materials testing devices and the use of large radiation sources. (Review article, 3 tabulations). (TTT)

2918 (NP-16366) ATOMIC ENERGY BOARD NINTH ANNUAL REPORT, 1965. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). 72p. Dep. mn.

Research progress on geology, extraction metallurgy, reactor engineering, physical metallurgy, chemistry, physics, isotopes and radiation, and life sciences is reported. Financial aid, technical activities, liaison and information affairs, and handling and control of radioactive material are discussed. (M.C.G.)

12210 10 JAHRE KERNFORSCHUNGSZENTRUM KARLSRUHE. (10 Years Nuclear Research Center Karlsruhe). Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1966. 201p.

The scope of the work done at the Karlsruhe nuclear research center is described by a series of articles outlining its 10 years of operation. The areas discussed are the fast breeder project, the Karlsruhe Research Reactor FR2, the isochronous cyclotron, the school for nuclear technology, neutron and reactor physics studies, applications of reactor physics, studies on vapor cooling, work on nuclear data and general neutron physics; nuclear and elementary particle physics, investigations on the chemistry of the transuranic elements, contribution to the processing of nuclear fuel elements, preparative radiochemical substitution of aromatic compounds in solutions, material and solid body studies, quantitative radiobiology, medications against radioactive poisonings, and studies on reactor engineering. (J.S.R.)

1411 PROGRESS OF RADIOCHEMICAL RESEARCH IN CZECHOSLOVAKIA. Chutny, Bohumir (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez); Plander, Emil. Jad. Energ., 12: 371-8(Oct. 1966). (In Czech).

A brief review is given of radiochemical research in Czechoslovakia and technological applications of radioisotopes in its industry. Extensive bibliographies are included. (R.V.J.)

19712 CATALOGUE OF RADIOACTIVE PRODUCTS, 1967/68. Amersham, Eng., Radiochemical Centre, United Kingdom Atomic Energy Authority. 215p.

The availability of radioactive products is listed under the following section headings: radioisotopes and labeled compounds; medical products; radiation sources (industrial and laboratory); radioactive material for instrument calibration; and services available. General information on ordering, distribution, packaging, delivery, insurance, prices and payment, and licensing and registration is also included. (UK)

19862 ISOTOPE SERVICES. Westholm, S.; Schmeling, P. (Aktiebolaget Atomenergi, Stockholm). Svensk Kem. Tidskr., 79: No. 2, 142-5(1967). (In Swedish).

General aspects on the production of radioactive substances for research, industrial, and medical use at the Swedish Atomic Energy Company are given. Methods for preparation and activation are reported. (INIS-Sweden)

9010 ATOMIC RESEARCH SERVES DANISH FARMING. Joergensen, J. Helms (Atomic Energy Commission, Riso, Denmark). Danish Foreign Office J., No. 52, 39-41(May 1965).

Research projects of the Denmark Department of Agriculture, Atomic Energy Commission, at Riso, Denmark, are outlined. Project studies encompassed research on fallout isotopes in soil and their uptake in plants; applied and theoretical research on the use of ionizing radiations for preservation and sprout inhibition of fresh fruit, vegetables, and potatoes; and plant breeding research that includes breeding methods and techniques in the utilization of ionizing radiations and mutagenic chemicals for inducing mutations in cultivated plants. Emphasis has been placed on obtaining cereal varieties that are resistant to root rot from pathogenic fungi. The aims of the program are to acquire knowledge of the pathogenic fungi and to develop resistant varieties of wheat and barley by using radiation. The two most serious root-rot fungi of resistant winter wheat being studied are *Cercospora herpotrichoides* and *Ophiobolus graminis*. Research is also being conducted on breeding methods for mildew resistance in barley; ~1,500,000 seedlings of irradiated barley are being tested at Riso for resistance to mildew fungus. (TSS)

1531 USE OF RADIOISOTOPES IN CONCRETE TECHNOLOGY FOR ACCELERATING HARDENING PROCESSES AND IMPROVING ITS CONTRACTION AND EXPANSION PROPERTIES. Novakovski, Boleslav. 15p. (In Russian). (CONF-641024-11). ORAU.

From Symposium on Use of Radioisotopes, Warsaw. Irradiation with gamma rays from a ⁶⁰Co source increased the rate of hardening of cement, but no effect on the final hardness of the product was observed. Mixes irradiated to 6000-600,000 rads were 47% more resistant to pressure on the third day after irradiation and 10% more resistant on the twenty-eighth day. This result is due to the dynamic state of the multiphase cement-water mixture, which contains crystals, colloids, molecules, and aqueous solutions. Any solids present are finely divided and, therefore, have a large surface area in contact with the aqueous phase. The radiation affects this surface, where new centers of solid phase growth arise, resulting in a better network of the matrix structure. The optimum radiation dose for accelerating the hardening process was not determined. The possible implications of these results to the economics of the concrete industry are discussed. (TTT)

10496 SOME ASPECTS OF THE APPLICATION OF NUCLEAR ENERGY TO LARGE CIVIL ENGINEERING PROJECTS. Keller, Anton (Gruner Freres, Basel). Trav. Publics Entrep., No. 54, 5-14(1965). (In French).

A summary is given of the important factors in the application of nuclear energy to civil engineering projects, particularly excavation projects. A general description is given of the technique of nuclear excavation. The radioactivity produced in nuclear excavations, its distribution, and the means of controlling it are indicated. (J.S.R.)

20323 (PEL-130) RADIOISOTOPES AND RADIATION IN HELMINTHOLOGY. A Bibliography. Rossouw, S. F. (comp.) (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Oct. 1966. 29p. Dep. mn.

Eighty-seven references are presented to literature published between 1948 and 1966 on the use of radiation and radioisotopes in the control of helminthic diseases in man and animals. (C.H.)

3041 APPLICATION OF RADIOISOTOPES IN THE RESEARCH OF PAINTS. Sokola, Karel (Research Inst. for Synthetic Resins and Lacquers, Pardubice, Czech.). Jad. Energ., 12: 222(June 1966). (In Czech).

A study of adhesion, desorption, and adsorption of the paints, permeability of films, aging during atmospheric exposure, and film formation is described. (JPRS)

1530 UTILIZATION OF VARIOUS RADIOISOTOPIC DEVICES AND METHODS IN THE OIL AND CHEMICAL INDUSTRIES. Dzha gatspanyan, R. V.; Drobiz, A. M. 23p. (In Russian). (CONF-641024-12). ORAU.

From Symposium on Use of Radioisotopes, Warsaw. Radioisotopes are used in measurement and control equipment,

as tracers, and for inducing chemical reactions. The radioisotope-containing gages, discussed here, provide for contactless and remote measurement of process and product variables, which is especially important when the reagents are corrosive or at high temperatures or pressures. Any effect of external conditions is thus eliminated, and measurements are made more rapidly. More than sixty such instruments have been developed in the USSR for measuring, for example, concentrations, levels, densities, and thicknesses. Their use in various industries is estimated to result in an annual saving of 240,000 rubles (\$260,000). Some of the variables measured or controlled are: concentration of sulfur in diesel fuel; levels in high-pressure separators (walls 200 to 300 mm thick) in coking plants, tank cars, and thermal cracking columns; charging of lime to furnaces for production of calcium carbide; production of Metafos (insecticide) and Freon; process of concentrating weak nitric acid; and the amount of the gamma isomer in hexachlorocyclohexane, which determines its insecticidal properties. (TTT)

3059 APPLICATION OF ISOTOPES IN PETROCHEMISTRY. APPLICATION OF ISOTOPES ON LUBRICATION MECHANISM AND ETHYLENE POLYMERIZATION. Ikeda, Sakuji (Tokyo Inst. of Tech.). Yukagaku, 14: 443-8 (Aug. 1965). (In Japanese).

The lubricating action of sulfur was studied by the use of ^{35}S .

The reaction mechanisms are, $\text{Fe} + \text{S}^* \xrightarrow{k_1} \text{FeS}^{**} + \frac{v_1}{k_2}$ outside of the reaction system. The reaction constants for both the reactions, n: initial surface concentration of Fe on the surface, c: S concentration combined with Fe on the surface, l: concentration of S adsorbed on the surface that participates in the reaction, are expressed as $C = k_1 l m / (k_1 l + k_2)$. In the process of replacing FeS^{**} with nonradioactive S, the decrease in the specific radioactivity of S is $-da/dt = \alpha v_2$, where α is the specific radioactivity of S^{**} combined with Fe, and v_2 is equal to $1/\alpha$

$[\alpha dc/dt + c d\alpha/dt]$. At the stationary state, $v_1 = v_2 = -\cos/\alpha \cdot d\alpha/dt$, and then $\ln(\alpha/\alpha_0) = -k_2 t$ is obtained. In the experiment, the contact surface area must be kept constant, and the absorption of β radiation and the "back diffraction" must be diminished. The polymerization mechanism of deuterioethylene was investigated. Cis- and trans-1,2-deuterioethylene were prepared and polymerized, and their polymer was investigated by the IR method. The IR spectra of cis-CHD = CHD differs from those of trans-CHD = CHD, and their fundamental frequencies for polymethylene chain are different from each other. (NSA of Japan)

16071 (NEIC-RR-15(Pt.1)) RADIOIZOTOPY W PRZEMYSLE. CZESC I. REFERATY ZBIORCZE WYGLOSZONE NA II KRAJOWYM SYMPOZJUM ZASTOSOWAN IZOTOPOW PROMIENIOTWORCZYCH W TECHNICIE, SPALA, 16-19 PAZDZIERNIKA 1963 R. (Radioisotopes in Industry. Part I. Second National Symposium on Technical Use of Radioisotopes, Spala, October 16-19, 1963). (Nuclear Energy Information Center, Warsaw (Poland)). 1965. 186p. (In Polish). (CONF-631010(Pt.1)). Dep. mn.

Ten papers are presented on the industrial applications of radioisotopes. Economic aspects of the industrial utilization of radioisotopes and radiometric methods and instrumentation used in physical and chemical analyses and research, and principles and practices of spectrochemical analysis are discussed. (R.V.J.)

6316 (AEC-tr-6466/2) THE USES OF RADIOACTIVE ISOTOPES AND NUCLEAR RADIATION IN THE U.S.S.R. PROCEEDINGS OF ALL-UNION CONFERENCE HELD IN RIGA, 12-16 APRIL 1960. VOLUME TWO. CONSTRUCTION AND BUILDING-MATERIALS INDUSTRY LIGHT INDUSTRY FOOD INDUSTRY AND AGRICULTURE MEDICINE. Petrov, N. A.; Petrenko, L. I.; Savitski, P. S. (eds.). Translated from Radioakt. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 2: (1961). 273p. (IPST-Cat.-1242; CONF-600402(Vol.2)). Dep. mn. CFSTI \$3.00 cy, \$0.65 mn.

The current status and prospects for future application of radioisotopes and nuclear radiations in the U.S.S.R. are reported. Topics discussed are the application of radioisotopes and nuclear radiations to the solution of industrial problems in the construction and building materials industry, light industry, food industry, agriculture, and medicine. (R.C.K.)

6317 (AEC-tr-6466/3) THE USES OF RADIOACTIVE ISOTOPES AND NUCLEAR RADIATION IN THE U.S.S.R. PROCEEDINGS OF ALL-UNION CONFERENCE HELD IN RIGA, 12-16 APRIL 1960. VOLUME THREE. MACHINE BUILDING AND METALLURGY. Rumyantsev, S. V.; Tsepaev, V. A.; Gruzin, P. L.; Lebedev, A. K.; Gerasimchuk, G. S. (eds.). Translated from Radioakt. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 3: (1961). 229p. (IPST-Cat.-1243; CONF-600402(Vol.3)). Dep. mn. CFSTI \$6.00 cy, \$1.25 mn.

The current state and prospects of the application of radioisotopes and nuclear radiation in machine building and in metallurgy are reported. In industry radioisotopes are reported being used in processing, quality control, and reliability testing of products from such areas as the automobile and engine industries, shipbuilding industry, and metallurgical and mining industries. The economics in using these methods, rather than the time consuming and often inaccurate conventional methods, are outlined. Other topics discussed are radiation sources, radiation detectors, and density, level and thickness gages. (B.G.D.)

6318 (AEC-tr-6466/4) THE USES OF RADIOACTIVE ISOTOPES AND NUCLEAR RADIATION IN THE U.S.S.R. PROCEEDINGS OF ALL-UNION CONFERENCE HELD IN RIGA, 12-16 APRIL 1960. VOLUME FOUR. SEARCH, PROSPECTING, AND EXPLOITATION OF MINERAL RESOURCES. Petrenko, L. I.; Savitski, P. S.; Speranski, M. A. (eds.). Translated from Radioakt. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 4: (1961). 320p. (IPST-Cat.-1244; CONF-600402(Vol.4)). Dep. mn. CFSTI \$7.00 cy, \$1.50 mn.

The current state and prospects of the application of radioisotopes and nuclear radiations for searching, prospecting, and exploitation of mineral resources in the U.S.S.R. are reported. Topics discussed are radiometric equipment and methods of well logging coal, gas, ore, and petroleum deposits; economic aspects of radiometric techniques, use of radioactive isotopes for geophysical purposes, and tracer techniques in geology. (B.G.D.)

8369 APPLICATIONS DES RAYONNEMENTS EN FRANCE. [VOLUME I]. (Applications of Radiation in France. Volume I). [Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966]. 235p.

Articles published in France in 1965 on the application of radiation are compiled. The first volume includes articles on irradiators and dosimetry, radiochemistry, radiobiology, and technological studies. Individual abstracts were prepared for 23 of the papers. The remaining 3 papers were previously abstracted for NSA and appeared as abstracts 19: 9182, 11626, and 26399. (J.S.R.)

For abstracts of individual papers see: 8370-8384, 8408, 8731, 9030, 9043-9045, 9259, and 9260.

8385 APPLICATIONS DES RAYONNEMENTS EN FRANCE. VOLUME II. (Applications of Radiation in France. Volume II). [Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay] 1966. 146p.

Articles published in France in 1965 on the application of radiation are compiled. The second volume includes articles on chemistry, biology, agriculture, and technological studies. Individual abstracts were prepared for five of the papers. The remaining 16 papers were previously published in NSA and appeared as 19: 15591, 17532, 40563, 40577, 40578 and 20: 2496, 5324, 8656, 10702, 10875, 14321, 14600, 14601, 18741, 23094, and 23559. (J.S.R.)

For abstracts of individual papers see: 8386-8389 and 9046.

5770 INDUSTRIAL APPLICATIONS OF RADIOISOTOPES. Taylor, K. J. (Wantage Research Lab., Eng.). Rep. Progr. Appl. Chem., 50: 131-43(1965).

Developments in the use of radioisotope techniques in analysis are chiefly considered, although other applications are covered in the extensive bibliography. Topics covered include: activation analysis, x-ray fluorescence analysis, coal ash, tracer applications, and radioisotope power development. (UK)

6144 (IA-1082, pp 255-88) APPLICATIONS. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

The use of radioisotopes and Soreq's large ^{60}Co radiation source for application in both industry and agriculture is reviewed. Authorization to use radiation for sprouting control of potatoes and

onions and for insect eradication in wheat was requested. Radioisotopes are being used in tracer studies of sand movement on the sea bed, movement of silt in dry watercourses, mixing conditions in pulp chests in paper mills, corrosion mechanisms, weight distribution of carbon black in rubber, and flows from submerged springs. The effects of radiation on sugar beets, avocado pears, potatoes, strawberries, and oranges were investigated. (R.C.K.)

19591 (AEC-tr-6716) COPRECIPITATION AND ADSORPTION OF RADIOACTIVE ELEMENTS. Vdovenko, V. M. (ed.). Translation of Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov, Izdatel'stvo Nauka, Moscow-Leningrad, 1965. 229p. (IPST-Cat.-1804). CFSTI \$3.00 cy, \$0. 65 mn. JCL \$15.00 fs, \$7.07 mf.

A cover-to-cover translation is presented for the book, which is a collection of original experimental and theoretical investigations on the coprecipitation and adsorption of radioactive isotopes. Thirty-one articles are included. (P.C.H.)

5989 (CONF-651081-) 4TH WORKING CONFERENCE ON STABLE ISOTOPES: SEPARATION, USE, AND ANALYSIS OF STABLE ISOTOPES AS WELL AS CHARACTERISTIC ISOTOPE SYSTEMS, LEIPZIG, GERMANY, OCTOBER 24-29, 1965. (Deutsche Akademie der Wissenschaften zu Berlin (East Germany)). 156p. (In German and Russian). Dep. mn.

Summaries of papers presented at the conference are grouped under the following topics: separation of stable isotopes; analysis of stable isotopes; research on characteristics of isotope systems; use of isotope systems; stable isotopes in biology, medicine, and agriculture; and isotope geology. (M.C.G.)

8303 PHYSICO-CHIMIE DU PROTACTINIUM. COLLOQUES INTERNATIONAUX, ORSAY, 2-8, JUILLET 1965. (Physical Chemistry of Protactinium. International Conference, Orsay, July 2-8, 1965). Paris, Centre National de la Recherche Scientifique, 1966. 351p. 56F. (CONF-650728-).

Separate abstracts were prepared for the thirty-eight papers presented. (D.H.M.)

For abstracts of individual papers see: 8304-8323, 8391, 8392, 8416-8425, 8483, 9094, 9167, 9240, 10058, and 10059.

132 TRANSPLUTONIUM ELEMENTS. Sary, Jiri; Caletka, Rostislav (Cs. Vysoke Ucení Technické, Prague. Inst. of Nuclear Research, Rez, Czech.). Chem. Listy, 60: 1267-96(Sept. 1966). (In Czech).

The preparation, separation, and chemical and radiochemical properties of the transplutonium elements are reviewed. Tables of isotopes, separation factors, extraction constants, and stability constants of complexes of transplutonium elements are presented. (138 references) (tr-auth)

4470 NOMENCLATURE OF RADIONUCLIDES. Sorantin, H.; Muellner, P. (Reaktorzentrum, Seibersdorf, Austria). Mikrochim. Acta, No. 6, 1153-5(1966). (In German).

For reasons of expediency, with respect to the neutron activation analysis, a more extended division based on the half-lives is proposed, both of the natural and the artificial radionuclides. (auth)

12864 PRINCIPLES AND UNITS IN RADIATION MEASUREMENTS: A SHORT REVIEW. Schinz, H. R.; Widersee, R. (Univ., Zurich). Indian J. Radiol., 18: 61-3(May 1964).

Difficulties and confusion regarding radiological measurements and their interpretation are discussed. To complete and clarify the system of measurements, a new special unit, the Planck (1 Planck = 3000 erg/cm²), is proposed for the energy fluence of the radiation field. (TSS)

16078 LES RADIOELEMENTS. PRODUCTION, DOSAGE, APPLICATIONS. (The Radioelements. Production, Dosage, Applications). Blanc, Daniel. Paris, Masson et Cie, 1966. 290p. 59 F.

A book, written for the researcher, engineer, or doctor, not having any special knowledge in the field of radioisotopes, is presented. The mathematics are simplified. The basic concepts of nuclear physics are first outlined. The principal procedures used for the production of radioelements are described. The particle detectors, associated circuits, and measurements of radioactivities are discussed. The dangers presented for the use of radioelements and the maximum permissible doses are considered. Examples are given of practical uses of radioelements. (J.S.R.)

10257 (AERE-Trans-1057) 25 YEARS OF NUCLEAR FISSION. METHODS AND RESULTS OF CHEMICAL STUDIES. 2. METHODS. Herrmann, G. Translated by A. Crozy (Atomic Energy Research Establishment, Harwell, Eng.), from Radiochim. Acta, 4: 173-88(1965). 48p. Dep. BIS \$1.40. HMSO 7s. 0d.

A review is presented on the detection of new short-lived fission products and study of mass distribution and charge distribution. Purely physical methods are discussed insofar as they apply to such problems. (168 references). (P.C.H.)

10454 NOMOGRAM FOR THE DETERMINATION OF THE DATE OF FORMATION OF MIXTURES OF RADIOACTIVE ISOTOPES. Varytshchenko, S. B. Radiokhimiya, 8: 611(1966). (In Russian).

A nomogram was constructed for determining the date of formation for radioactive mixtures. (J.S.R.)

4203 TABLE DES ISOTOPES. VOLUME II. (Tables of Isotopes. Volume II). Pannetier, Raymond. Vade-Mecum du Technicien. (Technicians Handbook). [Moulins, France, Maisonneuve S.A., 1965]. 300p.

A compilation is presented of the physical, chemical, nuclear, and radioactive characteristics of all known radioactive isotopes. (J.S.R.)

3008 PROCEEDINGS OF THE CONFERENCE ON APPLICATION OF PHYSICO-CHEMICAL METHODS IN THE CHEMICAL ANALYSIS HELD IN BUDAPEST, 20-23, APRIL 1966. VOLUME II. Buzas, Ilona (ed.). Budapest [Technical Univ. Hungarian Chemical Society], 1966. 554p. (CONF-660413-(Vol.2)).

Sixty-two articles are included. Twenty-five of them deal with chromatographic analyses, thirty-seven with radiochemistry and activation analyses. (J.G.B.)

15862 NUCLEAR METHODS IN CHEMICAL ANALYSIS. Broda, E.; Schoenfeld, T. (Univ. of Vienna). Acta Chim. Acad. Sci. Hung., 50: 49-62(1966).

A survey of nuclear methods in chemical analysis, covering applications of radioactive tracers, activation analysis as well as analysis with radionuclides as radiation sources, is given. Particular attention is given to classification for the various methods: (auth)

ISOTOPE PRODUCTION AND DEVELOPMENT

4674 GERMAN IMPORT STATISTICS FOR RADIOACTIVE MATERIALS. Schmidt-Kuester, W.-J. Atomwirtschaft, 11: 432-3(Aug.-Sept. 1966). (In German).

The use of radioactive materials for research, technology, and medicine increased in 1965 much more rapidly than expected. The imports yielded nearly the same quantity of activity as that imported in the preceding nine years. In addition to the much larger number of radioisotopes, which were used in greater quantities, especially impressive were the increases in the use of ¹⁹²Ir (materials testing), tritium, and ¹⁴⁷Pm (luminous paints), as well as ⁹⁰Sr (isotope batteries, which together reached more than 85% of the total imported activity with the exclusion of radiation sources over 50 curies (tr-auth)

Production

17667 PRODUCTION OF SHORT-LIVED RADIOISOTOPES. Eugenio, Manuel R.; Davila, Aida T. (Philippine Atomic Research Center, Diliman, Quezon City). Philippines Nucl. J., 1: No. 1, 17-21(July 1966).

A description of the Philippine Research Reactor facilities for irradiation and isotope production is given and processing methods adapted for some important short-lived radioisotopes currently being produced in the Center are described. The preparation of sealed sources is discussed. (auth)

1382 (ORNL-tr-1246) METHOD FOR PRODUCING A PHOSPHORUS ISOTOPE. Godar, S. Translated for Oak Ridge National Lab., Tenn., from Belgian Patent 633,780. 3p. Dep. mn. JCL \$1.10 fs, \$0.80 mf.

A method for producing $^{33}\text{P}_{15}$ by neutron irradiation of $^{33}\text{S}_{16}$, in which the reaction $^{33}\text{S}(n,p)^{33}\text{P}$ takes place, is described. The reaction is carried out with an accelerator, which produces protons of about 2.7 MeV that are used in the $^7\text{Li}(p,n)^7\text{Be}$ reaction, the neutrons of which react with the natural sulfur. (M.C.G.)

19714 PROCESS FOR THE PRODUCTION OF THE PHOSPHORUS ISOTOPE ^{33}P . Godar, Serge (to EURATOM). British Patent 1,057,154. Feb. 1, 1967. Priority date June 19, 1963, Belgium.

A process is described for the production of ^{33}P that is essentially free of ^{32}P by the reaction $^{33}\text{S}(n,p)^{33}\text{P}$ using natural S as the starting material. The characteristic feature of the method is the use of neutrons obtained by the use of accelerated protons having an energy of about 2.7 MeV to produce the reaction $^7\text{Li}(p,n)^7\text{Be}$. (B.L.M.)

21487 YIELD OF ^{22}Na PRODUCED IN NUCLEAR REACTIONS IN CYCLOTRON. Krasnov, N. N.; Dmitriev, P. P. At. Energ. (USSR), 21: 400-1 (Nov. 1966). (In Russian).

The yield of ^{22}Na produced by $\text{Mg} + d$ and $\text{Mg} + p$ reactions in a cyclotron was determined and was compared with the yield from other nuclear reactions reported elsewhere. The results showed that the most effective method for the production of ^{22}Na is the irradiation of magnesium with deuterons. (J.S.R.)

5904 (IA-1082, pp 21-4) RADIOISOTOPE PRODUCTION. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

The production of $^{88\text{m}}\text{Tc}$, neohydrin- ^{197}Hg , carrier-free ^{35}S , and colloidal ^{198}Au is discussed. Progress was made toward the production of beta and gamma standard calibration sources for energy calibration and as quantitative standards. (P.C.H.)

5908 (STI-DOC-10/63) MANUAL OF RADIOISOTOPE PRODUCTION. Technical Reports Series No. 63. (International Atomic Energy Agency, Vienna (Austria)). July 1966. 446p. IAEA: \$9.50; S 246,-; £ 3.7.0; F Fr 46,60; DM 38,-.

Technical and economic considerations that govern the planning and execution of an isotope program and experimental details of isotope production processes are discussed. Topics common to all radioisotope processing, namely laboratory design, handling and dispensing of radioactive solutions, quality control, measurement, and radiological safety, are covered. Information on the more common radioisotopes, ^{82}Br , ^{58}Co , ^{51}Cr , ^{64}Cu , ^{18}F , ^{198}Au , ^{131}I , ^{59}Fe , ^{24}Mg , ^{24}Na , ^{32}P , ^{35}S , ^{90}Y , and ^{65}Zn , is given. Their nuclear properties are described, references to typical applications are given, and published methods of production are reviewed. Descriptions of the production processes used at several national atomic energy organizations are given in detail. (D.H.M.)

5531 (JINR-P-2704) SINTEZ I OPREDELENIE RADIOAKTIVNYKH SVOISTV NEKOTORYKH IZOTOPOV FERMIYA. (Synthesis and Determination of Radioactive Properties of Some Fermium Isotopes). Akap'ev, G. N.; Demin, A. G.; Druin, V. A.; Imaev, E. G.; Kolesov, I. V.; Lobanov, Yu. V.; Pashchenko, L. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 11p. (In Russian). Dep. mn.

The experimental results of ^{238}U and ^{235}U bombardment with accelerated ^{16}O nuclei are described. A collection technique of the nuclear reaction products by gas entrainment was used. The α decay then was registered by (Si + Au) detectors. The excitation functions of ($^{16}\text{O}, xn$) reactions were investigated. Four fermium isotopes with mass numbers of 250, 249, 248, and 246 were identified. The α -particle energies and half lives of these isotopes were measured. An internal beam of the JINR 310-cm cyclotron was used. (auth)

8368 EXAMPLE OF THE PRODUCTION OF RADIONUCLIDES BY (γ, n) REACTIONS. Elias, H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 6: 109-10 (Oct. 1966). (In German).

The radioisotopes ^{46}Ti , ^{58}Co , ^{108}Ag , ^{126}I , ^{132}Cs , ^{202}Tl , and ^{203}Pb were prepared by (γ, n) reactions in a linear accelerator. By determination of the half life and recording of the γ spectra, the occurrence and the extent of interferences by other nuclear photo-reactions were determined. The only interfering reactions occurred in the preparation of ^{46}Ti by the formation of Sc isotopes by (γ, p) processes and ^{108}Ag by the formation of ^{105}Ag through ($\gamma, 2n$) reaction. (J.S.R.)

8051 THE USE OF THE HFR. Sneyvangers, J. J. M. Atomenergie Haar Toepass., 8: 179-87 (Aug. 1966). (In Dutch).

After a brief description of the high flux reactor, the experimental program of this reactor is considered. The physical experiments on fuel element irradiation, materials testing, and isotope production are described. (tr-auth)

Targets

3219 PREPARATION OF THICK ISOTOPIC TARGETS INSIDE AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Formann, E.; Viehboeck, F. P. (Oesterreichische Studiengesellschaft fuer Atomenergie, Vienna). Nucl. Instrum. Methods, 42: 331-2 (July 1966).

The method of preparing pure isotopic targets of several mg/cm² with the high dispersion Seibersdorf inhomogeneous magnetic field isotope separator by the sputtering method is described. (B.G.D.)

13773 PREPARATION OF ISOTOPIC LEAD AND BISMUTH TARGETS FOR NUCLEAR INVESTIGATIONS. Medyanik, V. N.; Karev, V. N.; Klyucharev, A. P. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Kh., 11: 560-2 (1966). (In Ukrainian).

An electrolytic bath containing the complexing agent Trilon B was examined as to its suitability for preparing isotopic targets. The metallic lead was dissolved in nitric acid, evaporated, and heated to 600 to 680°C, dissolving the yellow oxide formed in acetic acid. The crystallized lead acetate was then used to prepare the bath which contained 20 g/l Trilon B and had a pH between 4.5 and 4.9. A 20- μ -thick copper foil was used as a support for the deposition, removing it later with chromisulfuric acid. The deposition was carried out at a current density of 0.25 to 0.5 A/dm² with a lead anode. The shape and dimensions of the anode were found to affect the brilliance of the deposit. Uniform, nonporous lead layers were also obtained at higher current densities and at temperatures between 60 and 70°C. Foils of ^{208}Pb , ^{207}Pb , and ^{206}Pb were thus prepared. For the preparation of isotopically enriched bismuth foils, an electrolyte containing BiCl_3 was used in hydrochloric acid solution. The electrodeposition carried out at room temperature at a current density of 2.7 A/dm² yielded 2.0- to 10- μ -thick layers; a platinum cathode and a copper anode were used. (TIT)

19117 PREPARATION OF SEPARATED Mg ISOTOPE TARGETS BY REDUCTIVE EVAPORATION. Szalay, A.; Somorjai, E. (ATOMKI, Debrecen, Hungary). Nucl. Instrum. Methods, 49: 355 (1967).

MgO can be reduced and evaporated, into a thin Mg layer with almost 100% yield. The reduction is effected by Ta powder in a thin Ta tube heated by electron bombardment. A collimated Mg vapor beam emerges from the open end of the Ta tube. (auth)

Separation

10393 ON A METHOD FOR THE PRODUCTION OF CARRIER-FREE ^{18}F FROM NEUTRON IRRADIATED LITHIUM CARBONATE. Nikolov, K. (Sofia Univ.); Kolev, Z.; Mazhkarov, S.; Mutafchiev, K. Isotopenpraxis, 2: 433-5 (Nov. 1966). (In Russian).

An effective regime for the irradiation of Li_2CO_3 with neutrons and a method for the production of carrier-free ^{18}F and the construction of a device for the distillation of H^{18}F are described. This apparatus gives a choice of either operating with an open cycle in nitrogen gas as carrier of the H^{18}F or in a closed cycle with a constant volume of the carrier gas. According to the choice of regime of irradiation of the target material, a solution of Na^{18}F is obtained in the first case with a relative activity of about 350 to 400 $\mu\text{Ci/ml}$, (the total volume of the solution being 30 ml), and in the second case of 2.5 to 3 mCi/ml (the total volume of the solution being 5 ml). In view of decreasing losses in activity the adsorption of Na^{18}F on surfaces of glass, polyethylene, plexiglass, vinedur, and paraffin was studied, and also the dependence of adsorption on glass, vinedur, and paraffin on the pH of the solution. It was shown that the adsorption is largest on glass surface and smallest on surface of paraffin, and is negligible at values of pH > 7. (auth)

17721 PROBLEMS ON SEPARATION OF ZIRCONIUM FROM THE SUM OF FISSION FRAGMENTS. Krisyuk, I. T.; Usacheva, N. T. Radiokhimiya, 8: 709-10(1966). (In Russian).

Rapid preparation of short-lived zirconium fragments with a high specific activity was achieved by using pure alkalies and by reducing the accuracy of the final precipitate measurements to the order of $\leq 0.5\%$ (the interference activities of $\leq 0.5\%$ were not recorded). Verification of the half-life period of ^{87}Zr (17 hr) separated from irradiated uranium showed that a single precipitation of BaZrF_6 and zirconium phenylarsonate (instead of the three-stage precipitation) was sufficient for measurements with an order of accuracy of 0.5%. The rapid method produced zirconium with a small amount of carrier. The ratio of introduced active zirconium to that obtained after purification (within the order of error of 2 to 3%) was equal to 1. The experiment took 3 hr. (R.V.J.)

17726 SEPARATION OF NEPTUNIUM(IV), NEPTUNIUM(V), AND NEPTUNIUM(VI) BY EXTRACTION CHROMATOGRAPHY. Eschrich, Hubert (Institut für Atomenergie, Kjeller, Norway). Z. Anal. Chem., 226: 100-14(1967). (In German).

The applicability of reversed-phase chromatography with the partition system tributyl phosphate (TBP)/nitric acid to the separation of neptunium(IV), -(V), and -(VI) was investigated. The amounts of neptunium in the different oxidation states can be quantitatively separated on chromatographic TBP-columns by elution with 0.5 to 2M nitric acid at room temperature and a flow rate of $1 \text{ ml} \times \text{cm}^{-2} \times \text{min}^{-1}$. Some analytical and radiochemical applications of the separation method are given and possible interferences are discussed. (auth)

12480 FURNACE FOR THE PRODUCTION OF RADIOACTIVE IODINE. Bardy, Andre; Le Francois, Jacques; Murthy, Tantrauahi Suryanarayana (to Commissariat à l'Energie Atomique). British Patent 1,050,690, Dec. 7, 1966. Priority Date Oct. 2, 1964 and July 20, 1965, France.

A furnace is described for the production of ^{131}I by heating irradiated Te and removal of the vaporized ^{131}I by a neutral gas, such as argon. The furnace comprises a tubular muffle including the heating means, an inlet passage for the neutral gas at one end of the muffle, and gas discharge passage with heating means at the other end of the muffle. An orifice for loading the muffle is provided and is closed by a plug that can be moved parallel to the muffle axis and that can be pivoted transversely to clean the muffle orifice. The means for shifting and pivoting the plug can be remote means, such as two pneumatic jacks controlled from outside the hermetically sealed enclosure in which the furnace is placed.

The tubular muffle is made of or lined with a non-iodine-absorbent material, such as alumina. (B.L.M.)

14295 SOLVENT EXTRACTION OF PROTACTINIUM, NIOBIUM, AND TANTALUM FROM CITRATE SOLUTIONS. Rigali, L.; Barbano, P. G. (C.A.M.E.N., Pisa, Italy). Energ. Nucl. (Milan), 14: 168-71(Mar. 1967).

The extraction of protactinium, niobium, and tantalum from citrate solutions by xylene solutions of a quaternary ammonium compound (Aliquat-336) was investigated. Protactinium is the best extracted and the order of decreasing extractabilities is protactinium, tantalum, niobium; pH strongly affects the extraction of the three elements. Some experiments were done to determine the form of the complex extracted into the organic phase. (auth)

10295 THE SEPARATION OF CARRIER-FREE ^{54}Mn FROM IRRADIATED IRON BY REVERSED-PHASE PARTITION CHROMATOGRAPHY. Smulek, Wiktor (Inst. of Nuclear Research, Warsaw). Nukleonika, 11: 635-41(1966).

Reversed-phase partition chromatography has been applied to the separation of carrier-free ^{54}Mn from the neutron irradiated iron target. Tri-*n*-octylamine adsorbed onto siliconated kieselguhr was used as the stationary phase, and elution was carried out with hydrochloric and nitric acids. The procedure permits the separation of both micro- and macroamounts of both metals. (auth)

14290 SEPARATION OF ^{152}Eu , ^{147}Pm , ^{241}Am , AND ^{246}Cm THROUGH ELECTROPHORETIC FOCUSING USING THE SODIUM POLYPHOSPHATE AS COMPLEXING AGENT. Marcu, Gheorghe Stud. Univ. Babes-Bolyai, Ser. Chem., 11: No. 2, 61-6(1966). (In Rumanian).

Separation of some rare earths (^{152}Eu , ^{147}Pm) and of some transuranian elements (^{241}Am , ^{246}Cm) between them and between these families, was studied using sodium polyphosphates and the electrophoretic focusing method at a potential difference of $\sim 900 \text{ V}$. The duration of separation was 8 minutes. The best separations were obtained when using sodium polyphosphate of about 0.02 M. In these conditions at pH ~ 2.45 the ^{152}Eu separated

well from ^{246}Cm and ^{147}Pm from ^{241}Am . The best separation of ^{152}Eu from ^{147}Pm was obtained at pH ~ 5.50 . The ^{246}Cm separated from ^{241}Am only at pH ~ 7.0 , when the distance between their concentration zones was 8 mm. In the presence of europium and promethium the effectiveness of this separation increased to 14 mm. For group separation of the transuranian elements from rare earths the best separation was obtained at pH ~ 2.45 , when the distance between zones was 12 mm. (auth)

4612 SEPARATION OF CARRIER-FREE ^{105}Rh FROM NEUTRON-IRRADIATED RUTHENIUM. Morris, D. F. C.; Khan, M. A. (Brunel Univ., London). Radiochim. Acta, 6: 110-11 (Oct. 1966).

Irradiated ruthenium powder is mixed with potassium hydroxide, carbon tetrachloride and water are added, and chlorine passed through the mixture until all the ruthenium is converted to RuO_4 . The organic and aqueous phases are separated; the aqueous phase is acidified and ^{34}Fe and NH_4OH are added. The precipitate is dissolved in HCl and passed through an anion-exchange column. Tracer studies of the method showed that an overall yield of 85 to 87% is generally attainable. (M.C.G.)

6006 EXTRACTION OF RADIOISOTOPE-PURE CARRIER-FREE ^{140}Ba FROM URANIUM FISSION PRODUCTS. Tot, B.; Gromov, B. V. Radiokhimiya, 8: 84-8(1966). (In Russian).

The effects of UO_2^{2+} ions on the formations of mixed crystals of the type $\text{PbSO}_4 \cdot ^{140}\text{BaSO}_4$ and $\text{PbSO}_4 \cdot ^{88}\text{SrSO}_4$ were investigated. It was established that the basic principle of the extraction of radioisotopically pure ^{140}Ba from uranium fission products, also containing strontium isotopes, is the presence of uranyl ions in large quantities, which, because of the formation of complex compounds of uranyl sulfate, are capable of displacing strontium ions from the crystal lattice and can separate ions of lead and barium. (tr-auth)

4614 SEPARATION OF CARRIER-FREE ^{231}Th FROM ^{235}U . Glzon, A.; Lagrange, A.; Pelletier, A. M. (Centre d'Etudes Nucleaires, Grenoble, France). Radiochim. Acta, 6: 69-71 (Oct. 1966). (In French).

^{231}Th and ^{235}U are separated by elution on Dowex 1X8 with 9N HCl. Th^{4+} ions are fixed on Dowex 50 or Amberlite IR-100 and extracted by oxalic acid. ^{231}Th is evaporated in a vacuum at 1700 to 1800°C on thin films of formvar. (auth)

10388 PRODUCTION OF CARRIER-FREE ^{18}F . Kozyreva-Aleksandrova, L. S.; Levin, V. I.; Ivanov, Yu. F.; Zaleskii, V. G. Radiokhimiya, 8: 571-6(1966). (In Russian).

The sorption and desorption of carrier-free ^{18}F on column with hydrated zirconium oxide was investigated. $^{18}\text{F}^-$ fluoride was almost completely sorbed from neutral solutions on columns. The effects of the alkaline solution concentration on the speed of elution of the fluoride was established. An increase in solution concentration led to an increase in the elution speed. A method for the precipitation of ^{18}F from neutron-irradiated lithium carbonate, based on the sorption of the fluoride $^{18}\text{F}^-$ from neutral or weakly acid solutions on zirconium oxide hydrate columns with its subsequent elution with caustic soda, is proposed. ^{18}F with yields of $\sim 80\%$ was prepared. The concentration of ^{18}F in the preparations was not less than 99% and contained no more than 0.7% tritium and 0.2% ^{24}Na (within 5 hrs after the end of the irradiation). (tr-auth)

5992 (JINR-P-2877) BYSTRYI METOD POLUCHENIYA KONTSENTRIROVANNYKH RASTVOROV FRANTSIYA EKSTRAKTSIONNOI KHROMATOGRAFIIEI. (Fast Method of Preparing Concentrated Fr Solutions by Means of Extraction Chromatography). Mal'tseva, N. S.; Shalaevskii, M. R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 16p. (In Russian). Dep. mn.

A fast effective method is suggested for extracting Fr from Au foil bombarded with neon-22 ions by means of extraction chromatography. Francium is extracted by sodium tetraphenylboron solution in nitrobenzene. Francium is concentrated as drops, which permits the preparation of qualitative sources for α radiation measurement. The method can also be used for Cs radioisotope concentration. (auth)

17729 RAPID SEPARATION OF CERIUM AND MOLYBDENUM FROM FISSION PRODUCTS. Michelsen, Odd B.; Hoffman, Darleane (Institut for Atomenergi, Kjeller, Norway). *Radiochim. Acta*, 6: 165-7 (Dec. 1966).

A 4-min procedure based on extraction with hydrogen di-(2-ethylhexyl) orthophosphoric acid (HDEHP) was developed for separation of cerium from other fission products. Three alternative types of cerium sources were developed: liquid, solid, and column. While this procedure for cerium worked efficiently, a similar one developed for extraction of molybdenum from nitric acid solutions gave samples with extra radiation. This radiation was observed only after most of the Mo-Te radiation had died away, and was thought to be due to contamination of the sample by Te-I isotopes. (P.C.S.)

17668 RADIOCHEMICAL PURIFICATION OF THE ^{55}Fe ISOTOPE. Danilin, L. D.; Druzhinin, A. A.; Pavlova-Verevskina, I. *Radiokhimiya*, 8: 712-14 (1966). (In Russian).

Radiochemical purification was undertaken with ^{55}Fe prepared from an iron foil enriched up to 94.4 wt % in ^{54}Fe and irradiated in a reactor by thermal neutrons with integral intensities of 10^{21} neutrons/cm². Separated radioactive iron, such as ^{55}Fe , contained a small amount of ^{56}Fe isotopes with 1100 and 1290 keV γ energies, whose activity did not exceed 10⁻⁴% of the ^{55}Fe activity. Scintillation γ spectrometry with an NaI(Tl) crystal did not detect any ^{54}Mn and ^{60}Co impurities. (R.V.J.)

143 (EUR-2578,e) ISOLATION OF MICROGRAM AMOUNTS OF BERKELIUM AND CALIFORNIUM FROM IRRADIATED AMERICIUM. Kooi, J.; Gandolfo, J. M.; Waechter, N.; Wijkstra, J. (European Atomic Energy Community); Boden, R.; Hecq, R.; Vanhoof, E.; Leynen, M. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Dec. 1965. 46p. Dep. mn.

A description is given of the processing of a slug containing 2.5 grams of highly irradiated ^{241}Am from which approximately 200 milligrams of curium and microgram quantities of berkelium and californium were isolated. The processing included full-scale application of an extraction chromatography procedure using HDEHP-loaded columns. (auth)

19738 ADVANCES IN THE FIELD OF SEPARATING STABLE ISOTOPES BY CHEMICAL EXCHANGE. Ciric, M.; Krell,

E.; Kulicke, P.; Missbach, D.; Muehle, K.; Schuetze, H.; Stiehl, G.; Thiel, S.; Weise, G.; Wetzel, K. (Boris Kidric Inst. for Nuclear Research, Belgrade). *Isotopenpraxis*, 3: 21-6 (Jan. 1967). (In German).

Processes and methods utilized for the separation of various stable isotopes by chemical exchange are surveyed. A method for determining the rate of fast isotope-exchange reactions is described. (auth)

19752 PROCESS FOR CHEMICALLY SEPARATING SUBSTANCES IN SOLUTION. Laveissiere, Françoise; Bonnin, Andre; Poirier, Philippe (to Saint Gobain Techniques Nouvelles). British Patent 1,057,933. Feb. 8, 1967. Priority date Mar. 16, 1963, France.

A process is described for the extraction of a substance existing in the form of a salt dissolved in a solvent in mixture with other substances by the selective fixation of the substance to be extracted on a solid insoluble in the solvent. The process is particularly applicable to the separation of Cs present in radioactive wastes as a fission product in nitrate form from an aqueous solution possibly containing salts of other fission products. The solid fixative material is prepared in a dispersion in colloidal form, is flocculated, extracted, and redispersed in an organic solvent before it is brought into contact with the solution of the substance to be separated. For the fixation of Cs, a colloidal dispersion of mixed ferrocyanides containing cations from transition elements and monovalent cations is mixed with a surface active agent, such as a quaternary ammonium salt to produce flocculation of the colloid, and the colloid is redispersed in a water-immiscible chlorinated solvent, alcohol, ketone, or hydrocarbon. (B.L.M.)

14241 (KFK-tr-208) DER SZILARD-CHALMERS-EFFEKT UND SEINE ANWENDUNG. (The Szilard-Chalmers Effect and Its Application). Wang, Lien-Sheng. Translated into German by Peter Buriks (Kernforschungszentrum, Karlsruhe, West Ger.), from Hua Hsueh Tung Pao, No. 9, 264-9 (1964). 18p. Dep. mn. CFSTI \$3.00 cy, \$0.65 mn. JCL \$1.60 fs, \$0.80 mf.

A bibliographic review is given on the Szilard-Chalmers effect and its uses. The bases of this effect are described and some fundamental questions in the utilization of the Szilard-Chalmers effect for the enrichment of carrier-free radioisotopes are considered. Some examples of Szilard-Chalmers reactions are given. This reaction in strong radiation fields is described. The use of the Szilard-Chalmers effect in the preparation of labeled compounds and experimental techniques is briefly considered. (J.S.R.)

4673 (CEA-tr-A-1852) LE TUBE DE SEPARATION. XXV. REPARTITION DES CONCENTRATIONS D'UN MELANGE D'ISOTOPES A CONSTITUANTS MULTIPLES DANS UNE COLONNE DE THERMODIFFUSION. (Separation Column XXV. Separation of Concentrations of Isotopes in a Thermal Diffusion Column). Clusius, K.; Varde, E. Translated into French from *Helv. Chim. Acta*, 45: 2273-81 (1962). 26p. (In French). Dep. mn. JCL \$2.60 fs, \$0.98 mf.

The general scheme of the variation of the concentration or of the molar fraction of various isotopes of an element, in a separation column, was established as a function of the ζ coordinates along the length of the column, by taking in the first approximation the thermal diffusion coefficient proportional to the difference between the mass numbers of the two isotopes or isotope molecules. If the composition of the natural mixture is maintained unchanged at the origin point of the installation, the distribution of the isotopes of an element determined along the separation installation can be given directly in a $\gamma\zeta$ diagram. The curves corresponding to this open circuit operation are given for the elements Kr, Xe, S, and Se. The results showed that: the function representing the distribution of the isotope concentrations has, in general, no symmetry character; in agreement with experiment, only the two boundary isotopes of a series, that is, that of highest mass number and that of lowest mass number, can be obtained directly in the pure state; the median isotopes always pass through concentration maxima, which, in the first-order approximation, are found exactly at the point where mean mass number $\bar{m} = \sum_{k=1}^n m_k \gamma_k$ is identical to the mass number m_1 of the isotope considered: two concentration curves always intersect at a single point; the $\gamma\zeta$ diagrams, in the case of first-order approximation, are the same for all the compounds of the same element, for example, H_2S , D_2S , $^{12}\text{C}^{16}\text{O}_2$, S^{16}O_2 , SF_6 , as long as molecules that contain only a single atom of the element are considered, apart from the other pure elements; and the addition of an auxiliary gas introduces entirely new conditions because the thermal diffusion coefficients vary with concentration. (tr-auth)

4600 EFFECTS OF pH ON THE RADIOACTIVE ISOTOPE EXTRACTION FROM SOLUTIONS WITH COLLOIDAL IRON HYDROXIDE BY FOAM FORMATION METHOD. Pushkarev, V. V. *Radiokhimiya*, 8: 431-6 (1966). (In Russian).

For concentrating radioactive strontium, yttrium, and zirconium with niobium, ruthenium, cesium, and cerium from solutions by the foam formation method, conditions were studied for the separation of isotope carrier in the form of iron hydroxide colloids (50 mg/l) with the production of precipitates containing the largest quantity of moisture. It was established that the pH of the solution, gelatin content, air flow-through velocity across the column of liquid, and the difference in the surface level of the liquid and overflow height of the foam fractions show a significant effect on the precipitate moisture. Yttrium (at pH $\approx$ 6.0), zirconium with niobium (pH $\approx$

2.3), and cerium ($\text{pH} \geq 6.5$) were extracted from solutions with a 96.0 to 99.0% efficiency. The maximum extraction of ruthenium ($\text{pH} \approx 5.0$) is $\sim 90.0\%$, and that of strontium ($\text{pH} \approx 10.0$) was 97.0%. The dependence of the isotope extraction (with exclusion of strontium) with foam formation on the solution pH according to its character is analogous to the sorption from iron hydroxide under static conditions. The addition of small quantities of gelatin does not change the ion-forming nature of the sorption. The effect of foamers appears only in the character of the sorption of strontium. (tr-auth)

19711 A NEW METHOD FOR OBTAINING THE RADIOISOTOPES ^{54}Mn AND $^{55+56}\text{Fe}$ OF HIGH RADIOCHEMICAL PURITY. Bebesel, Pavel I.; Turcanu, Corneliu N. (Institut de Physique Atomique de l'Academie, Bucharest). Rev. Roum. Chim., 11: 1345-9 (Nov. 1966). (In French).

A method is presented for obtaining ^{54}Mn beginning with natural iron irradiated in the nuclear reactor VVR-S. The method makes evident the possibility of simultaneously obtaining ^{54}Mn and $^{55}\text{Fe} + ^{56}\text{Fe}$ of high radiochemical purity. The separation of ^{54}Mn is accomplished by its transformation into a colloidal solution of hydrated manganese dioxide and by its concentration on an aluminum column. The method is very simple and makes it possible to obtain ^{54}Mn and $^{55}\text{Fe} + ^{56}\text{Fe}$ with a maximum yield and in chemical forms easy to use. (tr-auth)

10387 CHROMATOGRAPHIC METHOD FOR THE PREPARATION OF CARRIER-FREE RADIOIODINE PREPARATIONS WITH HIGH SPECIFIC (VOLUME) ACTIVITY. Zaitseva, N. G.; Kim, Khon-sil; Khalkin, V. A. Radiokhimiya, 8: 576-84 (1966). (In Russian).

The previously unknown capacity of microquantities of iodine to be reversibly absorbed in the form of the chloride complex ICl_2^- on monofunctional sulfate cations of the type KU-2 and Dowex-50 from chlorine-saturated solutions of HCl and LiCl was found. The distribution coefficient is ~ 300 in 5 to 8M $\text{HCl}(\text{Cl}_2)$ and ~ 1000 in 9 to 11M $\text{LiCl}(\text{Cl}_2)$. On the basis of this result, a chromatographic method for the precipitation of carrier-free neutron-deficient iodine isotopes from lanthanum oxide irradiated with high-energy protons was developed. The preparations of radioiodine obtained were used for the preparation of high-grade sources, necessary for the investigation of the electron conversion spectrum. For this purpose, solutions containing iodine were dried on silver supports or the iodine was electrolytically precipitated on platinum cathodes from $\text{HCl}-\text{H}_2\text{SO}_4$ solutions. It was established

that the chromatographic method can be used for the separation of radioactive iodine isotopes from tellurium irradiated with thermal neutrons and from antimony irradiated with α particles. Preparations of iodine isotopes with a radioactivity of 1 to 2 c/ml is possible. The radiochemical purity of the preparations is more than 99.9%; the percentage of HCl is 2 to 3%. (tr-auth)

10336 INVESTIGATION OF THE COMPLEX FORMATION OF CURIUM AND EUROPIUM BY THE EXTRACTION METHOD. Stary, I. Radiokhimiya, 8: 509-13 (1966). (In Russian).

The extraction constants of curium ($\log K = -7.30 \pm 0.02$) and europium ($\log K = -7.18 \pm 0.03$) with 4,4,4-trifluoro-1-(2-thienyl)1,3-butanedione in benzene solvent were determined. The composition and stability constants of the complexes of curium and europium with tartaric acid ($\log \beta_2 = 6.84 \pm 0.03$ for Cm and $\log \beta_2 = 6.79 \pm 0.03$ for Eu), oxalic acid ($\log \beta_2 = 8.8$ and $\log \beta_3 = 12.1$ for Cm and Eu), nitrilotriacetic acid ($\log \beta_2 = 20.13 \pm 0.03$ for Cm and $\log \beta_2 = 20.42 \pm 0.02$ for Eu), ethylenedinitrilotetraacetic acid ($\log \beta_1 = 17.10 \pm 0.04$ for Cm and $\log \beta_1 = 17.34 \pm 0.02$ for Eu), and 1,2-dicyclohexylenedinitrilotetraacetic acid ($\log \beta_1 = 18.35 \pm 0.03$ for Cm and $\log \beta_1 = 18.51 \pm 0.03$ for Eu). It was shown that the stability of the curium complexes is greater than the stability of the analogous americium complexes but less than the stability of the corresponding europium complexes. (tr-auth)

10337 COMPLEX FORMATION OF NEPTUNIUM(IV) WITH NITRATE AND CHLORIDE IONS. Shilin, I. V.; Nazarov, V. K. Radiokhimiya, 8: 514-19 (1966). (In Russian).

The complex formation of tetravalent neptunium with nitrate and chloride ions was investigated. The values of the stability constants of the complex $[\text{Np}(\text{NO}_3)]^{3+}$ at ion strengths of 0.50, 1.00, 1.50, and 2.00 were equal to 2.80, 2.20, 2.30, and 2.00, respectively. The values of the stability constants of the complex $[\text{NpCl}]^{3+}$ for ion strengths of 0.50, 1.00, and 2.00 were equal to 1.40, 0.92, and 1.02, respectively. The thermodynamic stability constants of complexes of the type $[\text{MnO}_3]^{3+}$ were calculated for U^{4+} , Pu^{4+} , and Np^{4+} . (tr-auth)

10417 (KFK-432) DIE EXTRAKTION DER ELEMENTE RADIUM, ACTINIUM, PROTACTINIUM, AMERICIUM, UND CURIUM MIT 8-HYDROXYCHINOLIN. (Extraction of Radium, Actinium, Protactinium, Americium, and Curium Elements with 8-Hydroxyquinoline). Mosdzewski, Klaus (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). July 1966. 40p. (In German). Dep. mn.

The extraction behavior in the chelate formation of trace amounts of Ra^{2+} , Ac^{3+} , Am^{3+} , Cm^{3+} , and Pa^{5+} with 8-hydroxyquinoline (HOX) and its derivatives 5,7-dichloro-8-hydroxyquinoline (HDCO) and 5,7-dibrom-8-hydroxyquinoline (HDBO) were investigated. Ra^{2+} requires for its extraction high oxine and ligand anion concentrations. From the extraction curves it was determined that Ra^{2+} is extracted as $\text{Ra}(\text{OX})_2 \cdot 4\text{HOX}$, however the formation of $\text{Ra}(\text{OX})_2 \cdot 3\text{HOX}$ cannot be completely excluded. By addition of equal molar masses of *n*-butylamine to oxine, the extraction was improved with respect to that without addition to the oxine in weakly alkaline solution and worsened in strongly alkaline solutions. Ac^{3+} and Cm^{3+} were extracted with oxin from aqueous solution as $\text{AcY}(\text{OX})_2$ and $\text{CmY}(\text{OX})_2$ with $\text{Y} = \text{OH}^-$ probably, as was previously found for Am^{3+} . The extraction curve of Cm is identical with that of Am. The 50% extraction of Cm with 0.1 M HOX occurs at pH = 5.25 and that of Ac at pH = 6.62. The 50% extraction of Cm with 0.205 M HDBO occurs at pH = 5.09 and that of Am at pH = 5.05. The precipitation of Cm^{3+} with 0.04HDCO occurs at pH = 5.05. Because of the tendency of Pa^{5+} to hydrolyze, its extraction behavior with oxin and dibromooxine was investigated by reextraction. From the distribution curves for trace masses and microconcentrations 10^{-8} to 10^{-5} M Pa can be extracted as follows: Pa^{5+} forms with oxine a chelate of the average composition $\text{H}_2[\text{Pa}(\text{OH})_{4.6}(\text{OX})_{2.5}]$ and with dibromooxine $\text{H}_2[\text{Pa}(\text{OH})_6(\text{OX})]$ in addition to probable polymer species. The 50% extraction of Pa^{5+} with 0.1 M HOX occurs at pH = 1.35 and pH = 11.48 and with 10^{-3} M HDBO at pH = 11.6. (P.C.H.)

10339 INVESTIGATION OF THE COMPLEX FORMATION OF AMERICIUM AND PROMETHIUM BY THE EXTRACTION METHOD. Stary, I. Radiokhimiya, 8: 504-9 (1966). (In Russian).

The extraction constants of americium ($\log K = -7.48$) and promethium ($\log K = -7.84$) with 4,4,4-trifluoro-1-(2-thienyl)1,3-butanedione in benzene solvent were determined. The composition and stability constants of americium and promethium complexes with tartaric acid ($\log \beta_1 = 3.9$, $\log \beta_2 = 6.8$ for Am and Pm), oxalic acid ($\log \beta_2 = 8.3$, $\log \beta_3 = 11.8$ for Am and Pm), nitrilotriacetic acid ($\log \beta_2 = 19.71$ for Am $\log \beta_2 = 19.74$ for Pm), ethylenedinitrilotetraacetic acid ($\log \beta_1 = 16.91$ for Am $\log \beta_1 = 16.94$ for Pm), and 1,2-cyclohexylenedinitrilotetraacetic acid ($\log \beta_1 = 18.21$ for Am and $\log \beta_1 = 18.17$ for Pm) were determined. It was shown that americium complexes are closer to promethium complexes than to europium complexes with respect to stability. (tr-auth)

6003 RECOVERY OF IODIDE- ^{131}I FROM AQUEOUS SOLUTIONS OF pH 5. Oxby, C. B. (Univ. of Leeds, Eng.). Nature, 213: 68 (Jan. 7, 1967).

An unexpected dependence on the amount of carrier iodide was found in the recovery of radioactive iodide by solvent extraction (benzene) of its aqueous solutions containing NaNO_2 . The percentage recovery was inversely proportional to the amount of iodide in solution when the pH was between 4 and 7. The relationship was linear for the range of iodide concentrations examined (0.01 to 0.1 μg). This inverse relationship implies that an isotopic dilution effect occurs and that a constant amount of iodine is extracted. Mechanisms are discussed. Application to the possibility of developing a method for the determination of sub-microgram quantities of iodine is mentioned. Sensitivity and recovery were best at pH 5. (UK)

6004 SEPARATION OF $^{95,97}\text{Zr}$ AND $^{95,97}\text{Nb}$ FROM FISSION PRODUCT-MIXTURES AND IRRADIATED URANIUM BY AN EXTRACTION METHOD USING 8-QUINOLINOL. Motojima, Kenji; Hashitani, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 3: 326-32 (Aug. 1966).

An 8-quinolinol-extraction method was applied to separate ^{95}Zr - ^{95}Nb or ^{97}Nb from fission product mixtures and/or irradiated U. Radiochemically pure nuclides can be separated simply and rapidly from either origin. In the separation of ^{95}Zr - ^{95}Nb , the extraction was made from a solution of pH 4.5 to 5.5, containing acetate as masking agent. ^{95}Nb was extracted from a solution of pH 4.8 to 5.2, containing fluoride as masking agent, in the presence of U. ^{95}Nb can be separated from ^{95}Zr and other fission products by extraction from a solution of pH 5.3 to 8, containing EDTA as masking agent.

In these cases, after the first extraction, the chloroform solution should be washed with water to remove any remaining extraneous U or fission products. The addition of a small quantity of sulfite is required to prevent the extraction of ^{103}Ru . The method can be also used for the separation of the short-lived nuclides, ^{91}Zr - ^{97}Nb or ^{97}Nb , from irradiated U. (NSA of Japan)

157 THE ENRICHMENT OF ^{37}Cl BY COUNTER-CURRENT ELECTROLYSIS OF FUSED PbCl_2 . Selecki, Anatol; Czelej, Marek (Inst. of Nuclear Research, Warsaw). Nukleonika, 11: 437-40(1966). (In Polish).

The enrichment of ^{37}Cl was realized by countercurrent electromigration in molten PbCl_2 . The current density was 5 A/cm^2 . After 73 hr the concentration of ^{37}Cl obtained on the boundary, PbCl_2 -Pb (K), was 30.9%. It was calculated that in this case simple enrichment factor was 0.002. (auth)

8396 (AEC-E-152) FISSION PRODUCT SEPARATION FROM BERYLLIUM BY ION EXCHANGE. Fardy, J. J. (Austrian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1966. 34p. Dep. mn.

An ion-exchange process was developed on a laboratory scale for the separation of low-level fission product activity from beryllium in aqueous nitrate solution. A 97% recovery of beryllium with gross beta and gamma decontamination factors of 10^4 and 2×10^5 , respectively, was demonstrated. The process is flexible and should be applicable to both sulfate and chloride media. (auth)

3158 METHOD FOR SEPARATING AND CONCENTRATING ISOTOPES. Kakihana, Hideo (to Japan Atomic Fuel Corp.). Japanese Patent 1965-20000. Sept. 6, 1965. Filed June 21, 1963.

A method is proposed for separating and concentrating isotopes by electrophoresis. By using an ion exchanger on which direct current is applied to produce a potential gradient, ion-migration bands were formed by repeatedly supplying one species of different kinds of compounds to form a large number of the ion boundaries for the heterogeneous ions. In this method, the separating efficiency is not hindered. The amount of electric power consumed is not large since the electric migration of the ion pairs is hindered. Compared with the aqueous solution method, the separating efficiency is high because of the lower degree of ion hydration. In case of a granular ion exchanger, a reverse migration of the ion pairs is observed, but this is not seen in the proposed method. (NSA of Japan)

12517 METHOD FOR SEPARATING AND CONCENTRATING ISOTOPES. Fujiwara, Shizuo. Japanese Patent 1966-1680. Feb. 7, 1966. Filed Mar. 30, 1961.

A method is proposed for separating and concentrating certain isotopes in which a compound of a certain element is irradiated with ionizing radiation, such as deuterons, protons, neutrons, electrons, X, gamma, photons, and other electromagnetic radiations. The method is particularly applicable to compounds of nitrogen, and the volatile (gaseous) decomposition products that result are collected to obtain ^{15}N . (NSA of Japan)

1528 SEPARATION OF STABLE ISOTOPES OF THE RARE EARTHS. Formann, E.; Lugmair, G.; Ruedenauer, F.; Viehboeck, F. P.; Wotke, H. (Reaktorzentrum, Seibersdorf, Austria). Acta Phys. Austr., 23: 55-63(1966). (In German).

The mass separator used at the Seibersdorf reactor center for the separation of stable rare-earth isotopes is described. The ion source, the extraction system, and the collection system is considered in some detail. The efficiency of the installation is illustrated. (J.S.R.)

19863 PROCESS AND DEVICE FOR SEPARATING GASEOUS OR VAPOROUS SUBSTANCES ESPECIALLY ISOTOPES. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,056,782. Jan. 25, 1967. Priority date Mar. 9, 1963, Germany.

A process and apparatus are described for separating gaseous substances, especially isotopes, having different molecular weights and/or molecular diameters by ejecting a flow of the mixture through a nozzle-type orifice onto a dividing plate separating the jet from the orifice into two portions. A lighter gas is added to the jet prior to its forming, and the jet is deflected by mechanical

means by less than 360° after leaving the nozzle on the way to the dividing plate. The deflecting means is a concave plate, which connects the plate with means for removing the heavy portion of the gas mixture. A passage is provided for the removal of the light portion of the gas. The nozzle is formed by a part of the deflecting plate and the end of one wall of the passage for the removal of the light portion of the gas mixture. The adjacent end wall of the same passage is formed as a cutting edge that projects into the gas stream emanating from the nozzle and together with the part of the deflecting plate farthest from the nozzle forms the entrance to the passage for the removal of the heavy proportion of the gas mixture. (B.L.M.)

12511 SEPARATION OF URANIUM ISOTOPES ACCORDING TO THE SEPARATION JET PROCESS. Becker, E. W.; Bier, K.; Bier, W. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ing.-Tech., 39: No. 1, 1-7(Jan. 1967). (In German).

A separation-jet process, based on the partial spatial demixing of components of different mass in an expanding ultrasonic jet stream, is reported. It is of interest for the separation of uranium isotopes. The economic aspect of the process was considerably improved by increasing the mach number, by mixing the uranium hexafluoride with a light gas, and by increasing the angle of deflection of the flow planes with a bent deflection plate. Optimum process conditions are reported and the minimum specific costs achieved are compared with those of the diffusion process. (auth)

14292 TESTING THE JET SEPARATION PROCESS IN A CLOSED CIRCULATION SYSTEM. Schuette, R.; Seidel, D. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ing.-Tech., 39: 80-4(Jan. 24, 1967). (In German).

In the practical application of the jet separation process for separation of uranium isotopes, the elementary separation effect had to be repeated several times by arranging a large number of separating elements in series to form a cascade. A description is given of the construction and testing of a closed circulation system operated by a Roots impeller resistant to corrosion by UF_6 , the system comprising the basic unit of a ten-membered pilot cascade at present under construction. (auth)

6151 SEPARATION OF ISOTOPES BY THERMODIFFUSION. Varga-Manyi, P. (Medical Univ., Pecs, Hung.). Acta Blochim. Biophys., Acad. Sci. Hung., 1: 197-202(1966).

A three-walled glass vessel having a center tube with a reserve volume being formed on the lower and upper sides of the tube was used in an experiment to separate isotopes by thermodiffusion. A narrow slit of the thermodiffusion tube was filled with the solution to be investigated, that is, with ^{42}KCl , or 0.1M KCl and CaCl_2 solution labeled with $^{46}\text{CaCl}_2$. The temperature gradient at the two sides of the slit was established by continuously heating the inner side of the tube with steam and cooling the outer side with running tap water. To ensure the constant boiling of the distilled water, heaters of about 200 w capacity were used. The results showed that ^{42}K and ^{46}Ca could be separated in a liquid system by the aid of thermodiffusion. The efficiency of the separation was determined by the separation factor (q) which is given by the ratio of the values of the activity and sp act. of the samples taken from the lower and upper reserve volumes of the thermodiffusion tube. In most of the experiments $q > 1$. When the experiments were evaluated by the t test, the value $P = 0.05$ for the separation for K and Ca isotopes was significant. (BBB)

15975 (MLM-1375(tr)) THE FRACTIONING TUBE. XVII. PREPARATION OF THE RARE ISOTOPE ^{21}Ne IN A PURITY OF

99.6 PERCENT. Clusius, K.; Huber, M.; Huerzeler, H.; Schumacher, E. Translated from Mound Lab., Miamisburg, Ohio, from Z. Naturforsch., 11a: 702-9(1956). 19p. Dep. mn. CFSTI \$3.00 cy, \$0.65 mn. JCL \$1.60 fs, \$0.80 mf.

Starting with 60 liters of Ne, a concentrate is obtained in 5 steps which contains a maximum of 12.6% ^{21}Ne , whereas ordinary neon has only 0.257% of this isotope. The concentration distribution of the three isotopes ^{20}Ne , ^{21}Ne , and ^{22}Ne in the fractionating apparatus is measured and found in agreement with theory. By addition of a $\text{CD}_4/\text{CD}_3\text{H}/\text{CH}_2\text{D}_2$ mixture in a 175 day experiment, it was possible to remove ^{22}Ne , 3.95% ^{21}Ne , and 3.15% ^{20}Ne to such an extent that there remains a Ne of 99.6% ^{21}Ne containing only 0.2% each of ^{22}Ne and ^{20}Ne . This enrichment corresponds to a fractionation factor of 96,700. The purity of the gases obtained is illustrated by hyperfine structure photographs at the line 5852 Å. Technical data and discussion on the advantages of the auxiliary gas are appended. (P.C.H.)

12498 (JAERI-1115) ISOTOPE SEPARATION BY LIQUID-GAS CHEMICAL EXCHANGE. Ishida, K.; Mishima, M.; Matsuda, Y.; Komori, T.; Tamura, S. (Japan Atomic Energy Research Inst., Tokyo). June 1966. 14p. (In Japanese). Dep. mn.

The isotope separation process in a packed column in which two or more different chemical substances are brought into contact in the countercurrent flow was analyzed with the liquid-gas chemical exchange $\text{H}^{12}\text{CO}_3(\text{l}) + {}^{13}\text{CO}_2(\text{g}) \rightleftharpoons \text{H}^{13}\text{CO}_3(\text{l}) + {}^{12}\text{CO}_2(\text{g})$ as an example; the solution for the unsteady state in particular is discussed in detail. The effects on the enrichment of the column length, geometry and physicochemical properties of the packing material, liquid flowrate, isotopic exchange rate, temperature, and separation factor were studied by comparison of theoretical and experimental results. (auth)

14387 (CONF-660221-, pp 316-20) CONSTRUCTION OF AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Damodaran, K. K.; Gowariker, S. R. (Atomic Energy Establishment, Trombay (India)).

The construction of an electromagnetic separator is described. The separator is capable of separating isotopes of light, medium, and heavy mass numbers in milligram quantities. Three types of ion sources may be used for solid charges, for gaseous charges, and for charge materials with extremely high melting points. A schematic diagram of the isotope separator is given. (R.C.K.)

12588 ELECTROMAGNETIC SEPARATION OF HIGHLY ENRICHED NOBLE GAS ISOTOPES IN MULTIMILLIGRAM QUANTITIES. Hechtel, E.; Viehboeck, F. P. (Oesterreichische Studiengesellschaft fuer Atomenergie, Selbersdorf, Austria). Nucl. Instrum. Methods, 48: 323-7(1967). (SGAE-PH-44/1966).

A method for electromagnetic separation and for collection of multimilligram-quantities of noble gas isotopes is described. A charcoal collector cooled below 100°K was developed which is capable to store the separated noble gas isotopes during the separation. In a test run it was possible to collect 12 mg ${}^{135}\text{Xe}$ with an isotopic purity of 99.3%. (auth)

751 ISOTOPE SEPARATION. Holmberg, K. E. (Aktiebolaget Atomenergi, Stockholm). Svensk Kem. Tidskr., 79: No. 2, 131-5(1967). (In Swedish).

A survey of research and development on hydrogen and uranium isotope separation supported and achieved by the Swedish Atomic Energy Company is given. Exchange distillation was used for separation of boron isotopes. Different separation processes and isotopic systems were investigated. Research on separation effects for hydrogen isotopes, on formation of vapor or ice from salt solutions, and solubility of salts in heavy water are continued. (INIS-Sweden)

161 MERCURY MASS-DIFFUSION COLUMN FOR ISOTOPE SEPARATION. Nikolaev, B. I.; Neshchimenko, Yu. P.; Sulaberidze, G. A.; Lalayan, V. M. At. Energ. (USSR), 21: 62(July 1966). (In Russian).

Calculations on the mass diffusion process concerning the molecular weight of the materials in the gas phase and the molecular weights of the isotopes to be separated indicated that if parasitic effects in the columns, such as the solubility of the gas mixture in the condensate layer, are neglected, it is possible to achieve a very high degree of separation by using organic liquids. However, the previously used liquids, such as xylene, nitrobenzene, tetrachloroethylene, etc., are good solvents of the gases to be separated; on the other hand, the molecular weight of water is too low. Experiments were therefore carried out with metallic mercury as the liquid because it possesses a sufficiently high molecular weight together with the desired vapor pressure and the low solubility for the gases in question. A 1 m long column was used for separating neon isotopes, making sure that no metals forming amalgams were used for the structural portions. The separation tests, carried out with a double layer diaphragm and an operational pressure of 20 mm of Hg, yielded a separation factor of 17. (TTT)

17719 USE OF SYNTHETIC INORGANIC ION EXCHANGERS IN THE SEPARATION URANIUM, PLUTONIUM, AND FISSION PRODUCTS. Parra, M. Rodriguez; Hueda, A. Uriarte; Perez, B. Lopez (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 62: 1275-86(Dec. 1966). (In Spanish).

The variation of the distribution coefficients (K_D) for uranium cesium and plutonium ions in nitric solutions with two inorganic ion exchangers was studied. The exchangers were silica gel (<200 mesh) and Unfired Vycor Glass No. 7930 (100-200 mesh). Previously the exchangers were treated with 5M nitric acid and dried at 100°C. The effect of the nitric acid on the capacity of the exchangers was studied. The equilibrium times were determined. The effects of the temperature, nitric acid and concentration, and ion concentration in the aqueous phase on the distribution coefficients were studied. Complete separations between uranium and cesium, and between uranium and plutonium were achieved, because uranium was not fixed into the exchangers in the conditions tried. The separation between cesium and plutonium was almost complete at 50°C; at that temperature the distribution coefficients for cesium with both exchangers were about zero, and those for plutonium were about eight. (auth)

3155 USE OF NONAQUEOUS SOLVENTS FOR ISOLATION OF RADIOACTIVE ${}^{22}\text{Na}$ FROM IRRADIATED MAGNESIUM. Rudenko, N. P.; Zhukovskaya, A. S. Radiokhimiya, 8: 63-6 (1966). (In Russian).

Studies were made in which acetone and dioxane were substituted for ethanol in a previously reported procedure for recovering ${}^{22}\text{Na}$ from irradiated magnesium. It was found that the nature of the organic solvent added to the precipitate of magnesium sulfate did not affect the composition of the crystal hydrate formed. The solubility of magnesium sulfate in ethanol, acetone, and dioxane, and in their mixtures with water at 20°C was determined. The desorption of ${}^{22}\text{Na}$ from the surface of crystalline magnesium sulfate by these solvents was studied. It was established that solutions of acetone and dioxane containing 10 to 20% water exceed ethanol in desorptive capacity and are preferred for recovering radioactive ${}^{22}\text{Na}$ from a magnesium target. (J.G.B.)

14254 PRODUCTION OF CARRIER-FREE ${}^{24}\text{Na}$ BY IRRADIATION OF PURE Mg MATRICES IN POOL REACTORS. Malvano, R.; Rosa, U.; Grosso, P. (SORIN, Centro Ricerche Nucleari, Saluggia, Italy). Energ. Nucl. (Milan), 14: 161-7(Mar. 1967).

Carrier-free ${}^{24}\text{Na}$ can be produced by irradiating high-purity Mg matrices in the fast-neutron fluxes of pool-reactors. In particular, 13 to 26 mCi ${}^{24}\text{Na}$ per gram Mg can be obtained for 4-day irradiations in the RS1 reactor. A radiochemical method based on the electrodeposition of the ${}^{24}\text{Na}$ activity on a Hg cathode was developed: 0.5 g amounts of Mg can be processed in 4 hours, with nearly quantitative recoveries (93 ± 5%) and high decontamination factors from the matrix (1.5 to 5×10^3). The procedure is described and the results of some production experiments at mCi level are reported. The specific activity obtained when using 99.99% Mg was found to be in the order of 90 Ci/g, and the radiochemical purity about 99.9%, for 4-day irradiations at 2×10^{13} fast neutron/cm² s, taking into account a 15-hour decay (treatment and delivery time). (auth)

4616 IMPROVEMENTS IN OR RELATING TO SEPARATION OF FISSION PRODUCTS. Healy, Thomas Victor (to United Kingdom Atomic Energy Authority). British Patent 1,047,232. Nov. 2, 1966. Filed July 12, 1963.

The separation of fission products, such as Rb, Cs, Sr, Ba, Zr, Nb, and rare earths, by solvent extraction is described. An aqueous acidic solution of the fission products resulting from the irradiation of a nuclear reactor fuel material is treated with an organic solution containing bis(2-ethylhexyl) phosphate to give an organic phase and an aqueous phase containing strontium. The organic phase is washed with at least one aqueous solution of a mineral acid. (P.C.H.)

17727 RAPID SEPARATION METHODS FOR CESIUM FROM FISSION PRODUCT MIXTURES. Fiedler, H. J. (Univ., Mainz, McMaster Univ., Hamilton, Ont.); Archer, N. P. Z. Anal. Chem., 226: 114-22(1967). (In German).

Two fast separation methods of cesium from fission products are described, which yield rubidium-free samples. In the first method cesium is twice precipitated as tetraphenylborate from weak acid solution and then purified from rubidium by precipitating cesium bismuth iodide from acetic acid solution. In the second, faster method cesium is isolated by isotopic exchange with preformed cesium phosphomolybdate in 8N nitric acid and then purified as cesium bismuth iodide. The application of these methods in decay scheme studies of 9.5-min ^{138}Cs , 65-sec ^{140}Cs , 24-sec ^{141}Cs , and 18-min ^{141}Ba is briefly discussed. (auth)

17728 SEPARATION OF RARE EARTHS FROM NUCLEAR FISSION ON CATION EXCHANGERS. Seyb, Karl-Erich (Univ., Mainz). Z. Anal. Chem., 226: 159-70(1967). (In German).

The effect of several operation conditions on the ion exchange separation of rare earths with α -hydroxy isobutyric acid was studied. The composition of the eluant essentially determined the value of the separation factor and the sharpness of the eluted band. Good separations can be accomplished only with complexing solutions containing sufficient amounts of undissociated hydroxy acid. Variations of flow rate near 1 cm/min act on elutions in absence of undissociated hydroxy acid only. Other experiments showed strong temperature dependency of elution positions, but separations were of equal quality in the range of 50 to 83°C. Addition of carrier should be avoided; with amounts above 1 mg per cm² column cross section separation quality was reduced remarkably. In order to evaluate ion exchange experiments, the elution curves were plotted on probability graph paper with logarithmic abscissa resulting in straight lines. (auth)

17708 SYSTEMATIC INVESTIGATIONS ON THE SEPARATION OF $^{90}\text{Sr}/^{90}\text{Y}$ AND OF $^{140}\text{Ba}/^{140}\text{La}$ BY USE OF DOWEX-50 AS ION EXCHANGER AND LACTIC ACID AS COMPLEX FORMER. Lieser, K. H.; Baechmann, K. (Technische Hochschule, Darmstadt, Ger.). Z. Anal. Chem., 225: 379-91(Feb. 3, 1967). (In German).

Ion exchange as a function of time and pH dependence of the partition coefficients for Sr, Y, Ba, and La were measured, in order to find the optimum conditions for the separations $^{90}\text{Sr}/^{90}\text{Y}$ and $^{140}\text{Ba}/^{140}\text{La}$. The pH dependence of the partition coefficients and the separation factors are discussed in detail. To investigate the "milking" systems $^{90}\text{Sr}/^{90}\text{Y}$ and $^{140}\text{Ba}/^{140}\text{La}$ the activity distribution in the columns and in the eluate as well as the decontamination factors were measured. The optimum conditions for the separations are given. (auth)

14304 ISOLATION OF FISSION PRODUCTS AND THEIR APPLICATIONS. Awwal, M. A. (Univ. of New South Wales, Sydney). Nucleus (Lahore), 3: No. 1-2, 15-18(Jan.-June 1966).

Three different techniques for processing fuel elements for separation of fission products are outlined: the coprecipitation method, the solvent-extraction method, and the ion-exchange method. (M.C.G.)

Generators

149 PRODUCTION OF SHORT-LIVED ISOTOPES WITH THE AID OF ISOTOPE GENERATOR. Toerko, Janos. Magyar Kem. Lapja, 21: 459-64(Sept. 1966). (In Hungarian).

Generators for the production of short-lived isotopes are briefly discussed. A literature review is given regarding the construction and operation of generators within the scope of which the systems $^{90}\text{Sr}-^{90}\text{Y}$, $^{99}\text{Mo}-^{99\text{m}}\text{Tc}$, $^{87}\text{Y}-^{87\text{m}}\text{Sr}$, $^{132}\text{Te}-^{132}\text{I}$, $^{68}\text{Ge}-^{68}\text{Ga}$ and $^{115}\text{Cd}-^{115\text{m}}\text{In}$ are summarized. Besides the principal mathematical relations suitable for the calculation of activities produced the most important papers dealing with generators are discussed. (auth)

8407 PREPARATION OF ISOTOPES WITH SHORT HALF-LIVES BY MEANS OF ISOTOPE GENERATORS. Toerko, Janos. Magyar Kem. Lapja, 21: 459-64(Sept. 1966). (In Hungarian).

Mathematical equations characterizing the initial element-product element transformations, the separation methods employed in isotope generators, and some isotope generators available commercially are discussed. Among the latter, Y-90, Tc-99m, Sr-87m, I-132, Ga-68, and In-115m generators are discussed in some detail. Other isotopes produced by means of isotope generators include Al-28, K-42, Sc-44, Nb-95m, Rh-103m, In-113m, Ba-137m, La-140m, Pr-144, Pb-207m, and Ra(ThX)-224. (TSS)

10548 (NP-16437) NEWSLETTER NO. 2 OF THE ISOTOPIC GENERATOR INFORMATION CENTRE. (European Nuclear Energy Agency, Paris (France). Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1966. 32p. Dep. mn.

A review with comments on the UKAEA/ENEA Symposium on Industrial Applications for Isotopic Generators and the list of papers presented at the International Symposium on Industrial Applications for Isotopic Power Generators are presented. Also, a bibliography containing 57 references on dynamic conversion as applied to isotopic sources and a bibliography containing 37 references on recently published information on applications of radioisotopes are included. (F.S.)

Labeled Materials

4583 REACTIONS OF ^{38}Cl RECOIL ATOMS IN THE BINARY SYSTEM CCl_4 -BENZENE AND CCl_4 -TOLUENE. I. RECOIL CHLORINATION OF AROMATIC COMPOUNDS. Stoecklin, G.; Tornau, W. (Institut fuer Radiochemie, Juelich, Ger. Univ., Cologne). Radiochim. Acta, 6: 86-93(Oct. 1966). (In German).

The chemical reactions following the $^{37}\text{Cl}(n,\gamma)^{38}\text{Cl}$ process in the binary CCl_4 -benzene and the CCl_4 -toluene systems were investigated and the radiochemical yields of the different products were determined by radio-gaschromatography. A characteristic dependence of the $^{38}\text{ClCCl}_3$, $\text{C}_6\text{H}_5^{38}\text{Cl}$, and $\text{C}_7\text{H}_7^{38}\text{Cl}$ yields, respectively, can largely be attributed to a superposition of reactions of different chlorinating species. Accordingly, the recoil chlorination of benzene and toluene takes place via replacement reactions of "hot" ^{38}Cl atoms as well as via highly excited primary recoil products, $(^{38}\text{ClCl})^*$ and $(^{38}\text{ClCCl}_3)^*$. The distribution of the ^{38}Cl activity among the monochloro isomers of toluene in the CCl_4 -toluene system is dependent on the composition of the system and does not follow the classical rules of substitution. Contrary to the investigated γ radiolysis and the dark chlorination in the same system, the marked preference of the o-position decreases with an increase in the toluene concentration, whereas the substitution of the m-position as well as that of the side chain (benzyl chloride) increases. Almost statistically proceeding replacement reactions predominate. (auth)

10966 A CONTRIBUTION TO STUDIES ON RADIOACTIVE PHARMACEUTICALS. Mitchell, Joseph S. (Addenbrooke's Hospital, Cambridge, Eng. Cambridge Univ., Eng.). Strahlen-therapie, 131: 331-41(Nov. 1966). (In German).

This report deals with the most recent results of the clinical and laboratory studies of the possibility of using tritiated derivatives of Synkavit, especially TRK 219, tetrasodium 2-methyl-1,4-naphthohydroquinone-diphosphate, as a therapeutic agent. The evidence is based on 150 seriously ill patients with very advanced recurrent inoperable malignant tumors and reticulosos. In general, the results of treatment have been relatively modest. The practical dosimetry is discussed in some detail. In most of the cases only palliative treatment was possible. However, in certain cases, curative levels of radiation dosage could be delivered, especially after intra-arterial administration. In certain cases of advanced malignancy, unusual cells which concentrate the radioactive drugs are present in the bone marrow. Although they resemble tumor cells, much further work is necessary to identify them. (auth)

4497 PRODUCTION OF OXYGEN COMPOUNDS OF XENON BY β DECAY OF IODINE ISOTOPES AND STUDY OF THEIR PROPERTIES. Murin, A. N.; Kirin, I. S.; Nefedov, V. D.; Grachev, S. A.; Gusev, Yu. K.; Ivannikova, N. V.; Gusev, V. S. Radiokhimiya, 8: 449-54(1966). (In Russian).

The possibility of using chemical transformations during β decay of iodine isotopes for the synthesis of radioactive xenon trioxide was studied. A method was developed for the investigation of xenon compounds that were formed during the β decay of ^{131}I and ^{133}I as potassium iodate and periodate. (tr-auth)

8363 LABELING OF IODOBENZENE BY RADIOINDUCED ISOTOPIC EXCHANGE. Elias, H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 6: 107-9(Oct. 1966). (In German).

The preparation of iodine-labeled iodobenzene by radioinduced isotopic exchange was studied. Isotopic exchange and radiolysis in the $\text{C}_6\text{H}_5\text{I}-\text{I}_2$ system was investigated. The study showed that the radioinduced isotopic exchange between iodobenzene and iodine

proceeds in the presence of air at room temperature faster than the radiolytic decomposition of iodobenzene. The smaller the I concentration is, the smaller is the dose necessary for attainment of a given exchange rate. At $c_{\text{I}_2} = 0.0056 \text{ mol/l}$ and after absorption of $2.4 \times 10^6 \text{ r}$, the exchange rate equals 86%. No organic radiolysis products (benzene, biphenyl, diiodobenzene, and iodobiphenyl) are found in amounts of more than 0.1% and the iodobenzene contains these. The small amounts of organic radiolysis products can easily be separated after separation of the I_2 by fractional distillation or by gas chromatography. (J.S.R.)

5981 PRODUCTION OF XeO_3 BY β DECAY OF ^{131}I IN HIO_3 AND I_2O_5 COMPOSITION. Kirin, I. S.; Murin, A. N.; Nefedov, V. D.; Gusev, Yu. K.; Selikhov, G. G. Radiokhimiya, 8: 104-9(1966). (In Russian).

The possibility of the formation of the trioxide of ^{131}mXe during the β decay of ^{131}I in the compounds I_2O_5 and HIO_3 was examined. It was found that the introduction of XeO_3 as a carrier leads to an increase in the yield of the bound xenon. (tr-auth)

ISOTOPE TECHNOLOGY DEVELOPMENT

Activation Analysis

15861 AUTOMATIC AND COMPUTER-COUPLED NUCLEAR ACTIVATION ANALYSIS. Wainerdi, R. E.; Fite, L. E. (Texas A and M Univ., College Station). Acta Chim. Acad. Sci. Hung., 50: 33-8(1966).

A survey of the automatized measuring-system for activation analysis is given. Results achieved at the Texas University are discussed. (auth)

2997 ACTIVATION ANALYZER. Sucmatsu, Shigeru; Suganomata, Shinji (Hitachi Ltd., Tokyo). Hitachi Hyoron, 47: No. 11, 8-14(Nov. 1965). (In Japanese).

An apparatus for activation analysis was constructed, which consists of a neutron generator of 200 keV accelerating voltage and a pneumatic tube device to convey a sample between the activation device and measuring detector. The main features of the apparatus, such as the high-voltage generator, accelerator, air exhaust mechanism, pneumatic tube, and control mechanism, are described. By the use of a pneumatic tube, a sample in a case is first sent to the neutron source and after irradiation sent back to the detector automatically. In order to use the neutron source efficiently and to lengthen the life of the target, neutrons are generated only when a sample is on the irradiation table. Some examples of activation analyses, made on uranium compounds to determine the oxygen content, using this apparatus, are given. (NSA of Japan)

2954 INVESTIGATIONS IN NEUTRON ACTIVATION ANALYSIS. Brune, Dag (Aktiebolaget Atomenergi, Studsvik, Sweden). Svensk Kem. Tidskr., 78: 336-48(1966).

Numerous theoretical and practical aspects of selective activation by epithermal neutrons as applied to the determination of molybdenum in a steel alloy, whereby radiochemical separations were avoided, are discussed. In high-purity aluminum alloyed with Mg, the elements Cr, Cu, Fe, Ga, Hf, Mn, Sc, and Zn were determined. Chemical separations were obviated by proper choice of irradiation and decay times. The high resolution of the germanium semiconductor detector was demonstrated in determinations of nuclides with similar γ energies; the following pairs of nuclides were measured simultaneously: $^{136}\text{Cs}-^{137}\text{Cs}$, $^{42}\text{K}-^{24}\text{Na}$, $^{94}\text{Nb}-^{95}\text{Nb}$ and $^{95}\text{Zr}-^{95}\text{Nb}$. Reproducibility studies on the determination of 23 elements in biological specimens were also carried out. Descriptions are given of chemical separation techniques best suited for subsequent γ -spectrometric analysis. Levels of As, Au, Br, Cu, Fe, Mo, Se, and Zn in normal and uremic human whole blood were determined. A 10 times higher arsenic level in the uremic than normal blood was found. The distribution of Hg in human whole blood was studied by use of neutron irradiation at low temperature. The Szilard-Chalmers effect was employed for the separation of activities originating in neutron-irradiated biological material. Magnesium was determined in needle-biopsy specimens from living human muscle tissue using the Szilard-Chalmers separation technique. Two sources of error due to contamination from con-

tainer material, inherent in the irradiation of a sample, were investigated. They arise from recoil effects in the thermal neutron capture processes and from the rinsing of the irradiated container surfaces. By a freezing technique, aqueous samples were irradiated in the solid phase, so that sources of error arising from contamination, vaporization, and adsorption were avoided. (BBB)

4441 (ZFK-RCH-3) AKTIVIERUNGSANALYTISCHES KOLLOQUIUM, 10.-13. MAI 1965 IN ROSSENDORF. (KURZFASSUNGEN DER VORTRAEGE UND DISKUSSION). (Activation Analysis Colloquium, May 10-13, 1965, in Rossendorf, Short Summaries of the Reports and Discussions). (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany). Deutsches Akademie der Wissenschaften zu Berlin (East Germany)). Dec. 1965. 27p. (In German). (CONF-650579). Dep. mn.

Summaries are presented of the 26 reports given at the Activation Analysis Colloquium. These included: a review on the development of activation analysis, use of radioisotopes in analytical chemistry, determination of various elements in different materials, use of activation analysis in criminal investigations, system of automatic activation analysis with a neutron generator, application of the NA-1 neutron generator, boron determination in Si and Ge by proton and deuteron activation, oxygen determination on surfaces by triton activation, pneumatic fast irradiation installation for activation analysis, techniques of activation analysis with short-lived isotopes, determination limits in activation analysis, the sum coincidence method in activation analysis, selective activation in neutron activation analysis, and perturbations in the activation analysis by reactions with fast reactor neutrons. (P.C.H.)

1273 SOME RECENT HARWELL WORK ON ACTIVATION ANALYSIS. Pierce, T. B.; Smales, A. A. (Atomic Energy Research Establishment, Harwell, Eng.). Z. Anal. Chem., 221: 80-5(1966).

A review is given of recent work at Harwell on activation analysis. Slow and fast neutrons, charged particles, and γ rays all play their part as activating agents and examples are given. The measurement of "prompt" radiation using charged-particle irradiation is also mentioned. (auth)

12312 PLACE OF ACTIVATION ANALYSIS IN A RESEARCH ESTABLISHMENT DEALING WITH PURE MATERIALS. Smales, A. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 186-8 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

The advantages and disadvantages of activation analysis, as compared with other techniques for nonroutine analysis of pure materials, are evaluated. Criteria of sensitivity, specificity, contamination possibility, and accuracy of various techniques are considered. (J.G.B.)

10269 ACTIVATION ANALYSIS: A REVIEW. Coleman, R. F. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Pierce, T. B. *Analyst*, 92: 1-19 (Jan. 1967).

An attempt was made to indicate the diverse fields from which developments in technique have emanated, and to evaluate their significance. The emphasis is on work published during the past 3 years. A section briefly outlining the theoretical basis for the technique is included. Headings are as follows: nuclear interactions; irradiation facilities (nuclear reactors, accelerator neutron sources, isotopic neutron sources, charged particles, gamma photons); measurement of induced activity (radiochemical separations, rapid separations, group separations, automatic separation systems, and substoichiometry, gamma spectroscopy, other counting methods, prompt radiation techniques); and applications (high-purity materials, biology, forensic science, geochemistry, on-line analysis, surface analysis). (180 references). (UK)

1241 (CEA-R-3033) ANALYSE DE MELANGES DE RADIO-NUCLEIDES PAR UN DISPOSITIF SIMPLE DE COINCIDENCES

α - γ ET β - γ . (Analysis of Radionuclide Mixtures by α - γ and β - γ Coincidences Using a Simple Device). Pottier, Raymond; Berger, Rene (Commissariat à l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). June 1966. 44p. In French. Dep. mn.

A procedure is described for the qualitative and quantitative spectrographic analysis of radioactive sources containing two alpha-gamma emitters having the same alpha energy or two beta-gamma emitters having the same gamma energy. The main apparatus is a multichannel pulse-height analyzer including a coincidence circuit. The principle of the method, the synoptic scheme, the electronic device, the type of sources, and the precautions to be taken or the corrections to take into account are reported. The results obtained in solving the three following problems are discussed as examples of applications of the method: analysis for ^{241}Am in alpha-gamma sources containing ^{238}Pu ; analysis for ^{237}Np in beta-gamma sources containing ^{238}Pu ; and analysis for ^{106}Ru - ^{106}Rh in beta-gamma sources containing ^{85}Zr - ^{85}Nb . (auth)

2953 ANALYTICAL CHEMISTRY. Headridge, J. B. (Univ. of Sheffield, Eng.); Pierce, T. B.; Anderson, D. M. W. *Ann. Rep. Progr. Chem., Chem. Soc. London*, 62: 511-46 (1965).

Developments in analytical chemistry are reviewed including methods employing radiochemistry, activation analysis, and mass spectrometry. (570 references.) (TCO)

14172 METHODS OF RADIOCHEMICAL ANALYSIS. Geneva, World Health Organization, 1966. 164p. Pbound 1 3s, 6d., \$4.75; Sw. fr. 14.- (Clothbound Edition).

Methods for determining radioisotopes are described. Wherever possible, two methods are given for each nuclide: one highly sensitive and another perhaps less sensitive but rapid. Types of radioactive contamination likely to arise from various sources and the problems involved in measurement of environmental and human contamination are considered. The proper choice and collection of samples are described. The various types of errors that may affect assays of radioactivity and the checking procedures that may be adopted to counteract them are assessed. (M.C.G.)

10283 TECHNICAL AND PRACTICAL ASPECTS OF SPECTROMETRY FOR DETERMINATION OF RADIOACTIVE ISOTOPES IN MIXTURE. Danielson, B.; Delahayes, J.; Sjostrand, U. (Univ. of Uppsala). *Acta Soc. Med. Upsalienis*, 71: 173-95 (1966).

Some theoretical and practical aspects of spectrometry of radioisotope mixtures are summarized with special regard to the use of the method in biology. The maximum degree of activity for analysis was obtained by recording, when possible, both particle (β) and electromagnetic (γ and x) radiation. Large numbers of impulses were rapidly recorded by using energy channels comprising a large part of the energy spectra studied. The boundaries of the energy channels were placed over such parts of the energy spectra in which the counting rate was low so that the analytical results would be minimally influenced by variations in the amplification and pulse discrimination of the apparatus. In analysis of radioisotopic mixtures the error of the method was found to be small and the recovery good. Results are highly dependent on the stability of the apparatus and the analytical conditions. The amplification system of the apparatus must be stable in time, (stable high voltage is essential) and it must be independent of the input

pulse frequency. The volume and physical composition of the sample were also found to be of great importance in the analyses. On investigation of commercially available equipment it was found that the tube types were generally better than the transistorized ones. It was concluded that, provided stable equipment is used and that the analytical conditions are kept constant, the method described can be used for the analysis of radioisotope mixtures to give accurate results. (BBB)

10285 DETECTION LIMITS FOR COINCIDENCE METHODS IN ACTIVATION ANALYSIS. Schulze, Werner (Freie Univ., Berlin). *Z. Anal. Chem.*, 223: 1-10 (1966). (In German).

Equations of general validity were derived for the determination of the most favorable conditions in measuring a coincidence rate in presence of high-channel counting-rates having different half-lives. Diagrams are given which allow very simply to find the best counting time, the most favorable amount of the sample, and the value for the detectable coincidence rate. (auth)

12095 THE LIMIT OF IDENTIFICATION FOR SHORT-LIVED RADIOISOTOPES IN ACTIVATION ANALYSIS. THE LIMIT OF MEASUREMENT OF HALF-LIFE. Sterlinski, S. (Inst. of Nuclear Research, Warsaw). *Nucl. Instrum. Methods*, 47: 329-41 (1967).

A study was made of the identification for short-lived radioisotopes of low activity when the statistical fluctuation of counts from the effect and background blurs the univocality of the measured gamma-radiation energy (E_γ) and half-life ($T_{1/2}$). On the basis of theoretical analysis and experimental data, indications were formulated how to organize the measurement of $T_{1/2}$ to obtain the optimum accuracy of the estimate of this value. A formula and plots are presented for calculating the limited counting rate of the effect (i.e., the limited activity), at which the expected value of the accuracy of the estimate of $T_{1/2}$ can be obtained in a reasonably organized measurement. It was found experimentally that the limited activity for the measurement of $T_{1/2}$ is simultaneously sufficient for an adequately accurate estimate of the gamma energy radiation. The present investigation was undertaken primarily with the object of spectrometric measurements but some conclusions can also be applied in measurements of total activities. (auth)

1274 DETERMINATION OF DETECTION LIMITS IN ACTIVATION ANALYSIS WITH GAMMA SPECTROMETRY. Schulze, Werner (Freie Univ., Berlin). *Z. Anal. Chem.*, 221: 85-100 (1966). (In German).

Fundamental relations were derived for the amount of an element detectable by nondestructive activation analysis in presence of some arbitrarily chosen matrix material. Various cases in simple γ spectrometry are discussed, as well as coincidence methods. As an aid for the calculation of matrix counting-rates, a table was prepared, which shows the relative distribution of pulses in γ spectra up to 2.7 MeV for channels which extend over the half-width of the corresponding peaks. For the case of different half-lives in peak and background a diagram is given showing the most favourable counting time. The relation, derived for detectability of γ - γ coincidences, shows that the random rate is not restricted only to fractions of the true coincidence rate, but is allowed to have values some hundred times greater than the true coincidence rate, especially in presence of high channel counting-rates. (auth)

2944 RADIOISOTOPE X-RAY SPECTROMETRY. A REVIEW. Rhodes, J. R. (Atomic Energy Research Establishment, Wantage, Eng.). *Analyst*, 91: 683-99 (Nov. 1966).

The present state of development of x-ray excitation with radioisotope sources and relevant methods of nondispersive energy selection and x-ray detection are reviewed. Reduction of interferences arising from absorption, enhancement, and particle-size effects is also discussed. The compactness, cheapness, and simplicity of the measuring head that result from the use of radioisotope excitation and nondispersive energy selection are being exploited by portable and "on-stream" analysers now commercially available. The basic techniques of excitation and energy selection were worked out but not yet evaluated for all possible applications.

In many of the problems that were studied, alternative excitation and detection methods were used but not directly compared. Physical methods for overcoming absorption and enhancement effects were developed, mainly by analogy with conventional x-ray spectrometry. Suppression of particle-size effects in the analysis of heterogeneous materials remains a problem, especially as fusion techniques for removing the heterogeneity are virtually restricted to the laboratory. (auth)

3002 A CONTRIBUTION TO THE QUANTITATIVE ACTIVATION ANALYSIS DETERMINATION OF PURITY OF THE RARE EARTH OXIDES. Bildstein, H.; Auer-Welsbach, Helga (Oesterreichische Studiengesellschaft fuer Atomenergie, Vienna). *Monatsh. Chem.*, 97: 905-10(1966). (In German).

Quantitative determination of Eu in Gd, Pr in Nd, and Lu in Yb was performed by activation of the samples followed by separation on the cation exchanger Dowex 50W X8. Complete separation in the systems Eu-Gd and Pr-Nd was achieved with aqueous ammonium α -hydroxyisobutyrate solutions. Ammonium lactate gave better results with Yb and Lu. In all cases the reproducibility of the position of the elution peaks was satisfactory. Using this separation technique the residual impurities in the samples analyzed were estimated to be $0.065 \mu\text{g EuO}_{1.5}/\text{mg GdO}_{1.5}$; $1.2 \mu\text{g PrO}_{1.5}/\text{mg NdO}_{1.5}$, and $1.5 \mu\text{g LuO}_{1.5}/\text{mg YbO}_{1.5}$, respectively. (BBB)

2959 QUANTITATIVE ANALYSIS OF COMPLEX γ -RAY SPECTRA OF RADIOACTIVE METALS AND ALLOYS. Yanushkevich, V. A.; Ivanov, L. I. (Baikov Inst. of Metallurgy, USSR). *Zavodsk. Lab.*, 31: 699-702(1965). (In Russian).

A system of linear equations was derived for describing complex γ spectra of mixtures of radioisotopes in terms of the spectra of standards obtained under similar conditions, and the most probable solution in a form suitable for practical use in activation analysis of metals and alloys is given. The application to a Zr-Nb alloy is described. (Analytical Abstr.)

2967 ACTIVATION ANALYSIS OF TRACE IMPURITIES IN ALUMINIUM. Ko, Chiung-hui; Cheng, Hua-sheng (National Tsing Hua Univ., Hsinchu, Formosa). *J. Chin. Chem. Soc. (Taiwan)*, 12: No. 1-2, 39-50(1965).

Experimental details are given for the determination of Mn, Ni, Co, Cu, and Fe by activation analysis, and of Na and K by flame photometry. (Analytical Abstr.)

8225 THE NONDESTRUCTIVE ACTIVATION ANALYSIS DETERMINATION OF THE CHIEF CONSTITUENTS OF LARGER SAMPLE PIECES (EXAMPLE USED: COINS). Wytenbach, A. *Helv. Chim. Acta*, 49: 2555-63(1966). (In German).

A method of activation analysis for nondestructive determination of Ag, Cu, and Au in coins is described. Important characteristics of the method are the use of a rotating irradiation device, use of standards, which correspond as closely as possible to the shape and composition of the samples, and correction of the measured specific activities for variations in the Ag content and the thicknesses of the measured coins. The method was applied to 370 silver coins from the 15th and 16th centuries; the relative error amounted to $\pm 1.7\%$. (tr-auth)

1280 ACTIVATION ANALYSIS INVESTIGATION OF PAINTINGS. DETERMINATION OF TRACE CONTENTS OF WHITE LEAD OF PAINTINGS OF THE ALTE PINAKOTHEK AT MUNICH. Lux, Franz; Braunstein, Lothar (Technische Hochschule, Munich). *Z. Anal. Chem.*, 221: 235-54(1966). (In German).

Trace concentrations of Mn, Cu, Ba, Cr, Ag, and Sb in white-lead samples of paintings of the "Alte Pinakothek" were determined by activation analysis. In model experiments an analytical method comprising radiochemical separation and γ spectroscopy was developed. The limits of identification were about $5 \times 10^{-10}\text{g}$ for Ba, $2 \times 10^{-10}\text{g}$ for Cr, 10^{-10}g for Ag and Cu, and 10^{-11}g for Mn and Sb. Sometimes there was only $10 \mu\text{g}$ of white lead for one analysis. Predominately white-lead samples from paintings of Venetian and Dutch masters of the 16th and 17th centuries were analyzed. Modern and old white lead show great differences mainly in Cu and Ba concentrations; this may be used for the recognition of forgeries. (auth)

12329 MINOR CONSTITUENTS DETERMINATION IN COMPLEX MATERIALS BY ACTIVATION ANALYSIS WITH ISOTOPIC DOUBLE DILUTION FOR REMOVING THE ERRORS DUE TO SELF-SHIELDING, ENHANCEMENT AND NEUTRON RESONANCE. Cappadona, Carmelo (Univ., Palermo, Italy). pp 363-4 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Activation analysis allows rapid determination, and is competitive with other methods, for elements occurring in concentrations of 0.01% up to a few percent in complex materials such as animal and vegetable tissues, some alloys, soils and fertilizers, flours, mineral and sea water, etc. As big reactors are few and dispersed,

it is preferable to use the small reactors and generators. The sensitivity of the method is not sufficient for the determination of trace amounts in every case; thus, for the best use of the apparatus it is necessary to determine minor constituents. A wide range of application is possible in the analysis of complex substances for minor constituents (occurring in order of milligrams in irradiated samples) that give rise to radioisotopes having a half-life long enough to permit chemical separations. For this purpose a particular method is suggested which allows sample irradiation without standard and offers the great advantage of removing errors due to self-shielding, or enhancement, or neutron resonance. (auth)

Gamma

8220 POSSIBILITY OF ANALYSIS OF SOME METALS FOR OXYGEN BY COUNTING DELAYED NEUTRONS PRODUCED BY $^{18}\text{O}(\gamma, p)^{17}\text{N}$ REACTION. Dorosh, M. M.; Mazyukevitch, N. P.; Shkoda-Ulyanov, V. A. *At. Energ. (USSR)*, 21: 163-6(Sept. 1966). (In Russian).

The possibility of using $^{18}\text{O}(\gamma, p)^{17}\text{N}$ reactions for determining oxygen concentrations in metal bars by recording delayed neutrons is discussed. The yield of oxygen mixture from thick Be, Te, and Zr bars was calculated. The construction of strong-current mean energy accelerators would make a conveyor analysis of metals and alloys possible. (tr-auth)

14 PHOTOACTIVATION OF GALLIUM, INDIUM, AND THALLIUM BY 15 MeV BREMSSTRAHLUNG AND THE USES OF THE PRODUCTS IN ACTIVATION ANALYSIS. Oka, Yoshinaga; Kato, Toyooki (Tohoku Univ., Sendai). *Nippon Kagaku Zasshi*, 87: 1057-60(Oct. 1966). (In Japanese).

The advantages of the use of 15 MeV bremsstrahlung radiation in activation analyses of gallium and thallium in indium matrix, and thallium in gallium-indium mixtures are discussed. Individual metals and synthetic mixtures of gallium-indium-thallium in different mixing ratio were irradiated for 1 hr, and the photopeaks of $0.511 \text{ MeV } \gamma$ ray of ^{68}Ga and of $0.439 \text{ MeV } \gamma$ ray of ^{202}Tl were measured. The matrix indium was used as an internal monitor of bremsstrahlung dose rate, and the radioactivities of the residual $^{114\text{m}}\text{In}$ were estimated by its $0.190 \text{ MeV } \gamma$ photopeak. Sensitivities of about $20 \mu\text{g}$ for gallium and about $10 \mu\text{g}$ for thallium in the indium matrix were obtained. One tenth per cent thallium content or less in the gallium matrix was found to be determinable by this method. (auth)

12356 PHOTOACTIVATION OF GERMANIUM AND ITS APPLICATION TO THE DETERMINATION OF GERMANIUM IN IRON. Abe, Shigeki (Yamagata Univ., Japan). *Nippon Kagaku Zasshi*, 88: 52-6(Jan. 1967). (In Japanese).

Based on the results of photoactivation of germanium, a method for nondestructive determination of germanium in iron was developed. Germanium oxide was irradiated for an hour with 20 MeV bremsstrahlung generated from the linear electron accelerator. The γ spectrum of photoactivated germanium showed a prominent photopeak of ^{76}Ge at 0.26 MeV and those of ^{68}Ge at 0.51 , 0.88 , 1.12 , and 1.34 MeV . These photopeaks decayed with the half-lives of 82 min and 40.4 hr for ^{76}Ge and ^{68}Ge , respectively. Both ^{68}Ge and ^{76}Ge were produced by (γ, n) reaction of germanium. For the determination of germanium in iron oxide, the ^{56}Mn activity, which was produced by (γ, p) reaction of iron, was used as the internal monitor of photon flux intensity. The photopeak activity ratios of $^{68}\text{Ge}(0.51 \text{ MeV})/^{56}\text{Mn}(0.85 \text{ MeV})$ and $^{68}\text{Ge}(1.12 \text{ MeV})/^{56}\text{Mn}(0.85 \text{ MeV})$ vs the weight ratios of Ge/Fe were plotted and the linear relation was obtained. Germanium in iron oxide was determined nondestructively to about 0.1% . (auth)

19540 POSSIBILITY OF USE OF PHOTONEUTRON METHOD FOR DETERMINATION OF HYDROGEN IN METALS. Mazyukovich, N. P.; Shkoda-Ul'yanov, V. A. *At. Energ. (USSR)*, 21: 388-9 (Nov. 1966). (In Russian).

The photoneutrons from hydrogen and beryllium, present in lead in quantities of $10^{-4}\%$, were calculated in the energy interval from the (γ, n) threshold reaction at $E = 6.71$ Mev. Tabulated results showed that if the admixture of beryllium is 2 to 3 times less than that of hydrogen, then hydrogen can be determined by the photoneutron method. As literature data show Be is present in U in quantities of $10^{-6}\%$, 10^{-3} to $10^{-4}\%$ H_2 can be determined in U by this method. The photoneutron registration necessary for statistical precision in lead containing $10^{-4}\%$ H_2 and $10^{-6}\%$ Be is 5%. (J.S.R.)

10077 (ANL-Trans-375) STUDIES ON THE RADIOACTIVATION BY THE ^{60}Co γ -RAY SOURCE. I. GENERAL CONSIDERATIONS ON THE RADIOACTIVATION BY THE USE OF A γ -RAY SOURCE OF RADIOISOTOPE. Yoshihara, Kenji. Translated for Argonne National Lab., Ill., from Daitai To Hoshasen, 3: 276-85 (1960). 16p. Dep. mn. JCL \$1.60 fs, \$0.80 ml.

Radioactivation by use of a radioisotope γ source is treated on the basis of the theory of Compton scattering. The Klein-Nishina formula was applied to estimate the flux of the resonance γ ray effective for this activation reaction. The overall cross section (σ) of a nuclide for radioactivation is expressed as follows: $\sigma = \sigma_1 + \sigma_2 + \sigma_3 + \sigma_4$, where σ_1 is Compton scattering in the source itself, σ_2 is scattering by intermediate substances, σ_3 is the wall, and σ_4 is the target itself. The value for σ_3 can not be estimated generally because of the complexity of the wall effect. But the other three terms can be easily calculated using simplified models. Assuming a spherical source for calculation of σ_1 , a formula was obtained, $\sigma_1 = K \cdot n_{01} \cdot \phi \cdot \sigma_a \cdot e^{(\mu_1 - \mu_1')R} (1 - e^{-\mu_1 R}) / \mu_1$ and $K = e^{(\mu_1 - \mu_1')\rho}$, where n_{01} is an electron density per unit volume of the source substance, ϕ is the cross section of an electron for production of the γ ray effective for this activation reaction, σ is the activation cross section of the nuclide for the effective γ ray, μ_1 and μ_1' are the absorption coefficients of the source substance to the original γ ray and the resonance γ ray respectively, R is the radius of the source, μ_2 and μ_2' are the absorption coefficients of the intermediate substance to the original γ ray and the resonance γ ray, respectively, and ρ is the thickness of the intermediate substance. The equation for determining σ_2 is $\sigma_2 = n_{02} \cdot \phi \cdot \sigma_a (1 - e^{(\mu_1 - \mu_1')\rho}) / \mu_2' - \mu_2$ where n_{02} is an electron density per unit volume of the intermediate substance. The equation for determining σ_4 is

$$\sigma_4 = \frac{n_{04} \cdot \phi \cdot \sigma_a}{\mu_4} \left(1 - \frac{1}{\mu_4 l} + \frac{e^{-\mu_4 l}}{\mu_4 l} \right)$$

where n_{04} is an electron density per unit volume of the target, μ_4 is the absorption coefficient of the target for the original γ ray, and l is thickness of the target. (auth)

Charged Particles

3007 LOW ENERGY 3He ACTIVATION ANALYSES FOR CARBON AND OXYGEN. Gorodetzky, S.; Pape, A.; Chevallier, A.; Sens, J. C.; Armbruster, R. (*Institut de Recherches Nucleaires, Strasbourg*). *Nucl. Instrum. Methods*, 42: 269-72 (July 1966).

The possibility of using 3He ions accelerated to kinetic energies below 5.5 MeV in activation analyses for carbon and oxygen was investigated. Radiations from ^{11}C and ^{18}F produced in the 3He bombardments of carbon and oxygen, respectively, were used to detect the presence of these elements. Using the stacked foil method with targets of known composition, the cross sections for the $^3He + C \rightarrow ^{11}C$ and $^3He + O \rightarrow ^{18}F$ reactions were measured as a function of energy up to 5.5 MeV. The results show that both reactions have cross sections in the tens of mb at a 3He laboratory energy as low as 2 MeV. The $^3He + N \rightarrow ^{13}N$ reaction, which can serve as the detecting reaction for nitrogen, was determined to have much lower cross sections. (auth)

1237 (AE-237) MICROANALYSIS OF FLUORINE CONTAMINATION AND ITS DEPTH DISTRIBUTION IN ZIRCALOY BY THE USE OF A CHARGED PARTICLE NUCLEAR REACTION. Moeller, E.; Starfelt, N. (*Aktiebolaget Atomenergi, Stockholm (Sweden)*). July 1966. 16p. Dep. mn.

Fluorine contamination on and below the surface of Zircaloy was

studied by means of proton irradiation using a Van de Graaff accelerator and the detection of prompt gamma radiation from the $^{18}F(p, \alpha \gamma)^{15}O$ reaction. Formulas for deriving depth distributions of impurities from the measured counting rates were derived. The influence of energy straggling on the depth resolution was studied. Both the total amount and the depth distribution were measured in samples, which had undergone different treatments. Because of the high yield from the reaction used, a quantity of fluorine less than $0.01 \mu g/cm^2$ can be detected by this method. (auth)

1304 OXYGEN DETERMINATION USING TRITON ACTIVATION. de Goey, J. J. M.; Houtman, J. P. W. (*Reactor Instituut, Delft, Netherlands*). 25p. (CONF-650405-27). ORAU.

From International Conference on Modern Trends in Activation Analysis, College Station, Tex.

The determination of oxygen by triton activation was applied to the analysis of foils covered with Li-containing films and to powders in a mechanical mixture containing a Li compound. Data are tabulated for relative ranges of tritons and relative stopping powers of certain substances, which make it possible to compare O_2 contents, and thus also the ^{18}F activity, in different materials for various sandwich systems and for a homogeneous system. The relative range data also provide direct information about surface layer thickness. The method is discussed with particular reference to determination of Al_2O_3 layers on Al, of O in Li-Al-Mg alloy, of O in organic materials, and of surface O in polyolefins. The method suffers from interference from a number of elements, and chemical separation is often necessary. (B.L.M.)

10265 ACTIVATION ANALYSIS OF OXYGEN AT THE SURFACE OF SOLIDS. Wilkiss, P. E.; Born, H. J. (*Technische Hochschule, Munich*). *Int. J. Appl. Radiat. Isotop.*, 18: 57-64 (Jan. 1967). (In German).

The possibilities for the determination of oxygen by activation

analysis at the surface of solid samples were investigated using the nuclear reaction $^{18}O(t, n)^{18}F$. The decrease of the activation of oxygen in aluminum was calculated and measured. Two methods for the determination of oxygen at surfaces were investigated. One uses tritons which impinge at small angles to the surface, the other uses the recoil of the ^{18}F -atoms. (auth)

12327 ACTIVATION WITH PHOTONS OR CHARGED PARTICLES FOR THE ANALYSIS OF NONMETALLIC ELEMENTS. Engelmann, C.; Cabane, G. (*CEN, Saclay, France*). pp 331-6

of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Methods of activation were sought, which might produce usable isotopes with elements such as oxygen, carbon, nitrogen, phosphorus, etc. The methods had to be sensitive to concentrations as low as 1 ppm, and the activation ought to be so specific that no dissolution and chemical separation would be needed. A prospect of the nuclear reactions that might be produced by photons or charged particles, suitably accelerated, shows possibilities for this kind of activation analysis. More precisely, the following were used: a linear accelerator giving electrons up to 40 MeV and producing α rays by the slowing down of these electrons in a platinum target; a cyclotron accelerating α particles to 44 MeV; another cyclotron, built by Philips, which produces an external beam of protons whose energies may be adjusted from 3 to 30 MeV. The first two accelerators were connected to the counting room by rabbits, so that the personnel were not irradiated by coming too close to the accelerator and activities of half-lives no longer than 2 min were easily registered. Present research is based on: control, several thousands of analyses of impurities (mainly oxygen, carbon and nitrogen) in zone-refined beryllium, and some other nuclear materials, and research, activating standards at various energy levels to determine the conditions of specific activation of given impurities and finding a new method to calculate the volume activated by charged particles whose nuclear cross section varies as they slow down in very small thicknesses. The studies allowed many determinations of trace amounts of oxygen, carbon, nitrogen, and fluorine in nuclear materials; the conditions for the analysis of boron, phosphorus, and sulfur were determined; these analyses are usually nondestructive and their sensitivities are better than 10^{-7} g; in some specific cases they can detect less than 10^{-8} g. (auth)

4447 DETERMINATION OF Mg BY ACTIVATION WITH TRITONS PRODUCED IN A NUCLEAR REACTOR AS A RESULT OF THE ACTION OF NEUTRONS OF LITHIUM FLUORIDE. Pauly, Jules; Sabbioni, Enrico; Girardi, Francesco (EURATOM, Ispra, Italy). *Compt. Rend., Ser. C* 263: 870-1 (Oct. 10, 1966). (In French).

Mg was determined by incorporating the sample to be analyzed in a lithium fluoride tablet and irradiating it in a reactor. The tritons obtained by the $^6\text{Li}(n,\alpha)^3\text{H}$ reaction react with the Mg to give ^{28}Mg . After chemical separation the radioactive Mg is measured by γ spectrometry using a semiconductor detector or a NaI(Tl) crystal. The detection limit for the determination is 0.2 μg . (tr-auth)

8211 DETERMINATION OF ^{18}O CONTENT BY MEANS OF DETECTION OF γ QUANTUM EMITTED FROM $^{18}\text{O}(\alpha,n\gamma)^{21}\text{Ne}$ REACTION. Lemberg, I. Kh.; Girshin, A. B.; Gusinskii, G. M. (Ioffe Inst. of Physics and Tech., Leningrad). *Zavodsk. Lab.*, 32: 1499-1501 (1966). (In Russian).

A method is suggested for determining the content of stable ^{18}O isotope by the $^{18}\text{O}(\alpha,n\gamma)^{21}\text{Ne}$ reaction using α particles accelerated by a cyclotron to 4.6 MeV. The content of ^{18}O was determined by the yield of γ quanta emitted by the excited ^{21}Ne . Obsolete sensitivity of the method for ^{18}O was 2×10^{-3} g, and for the natural oxygen 10^{-6} g. (tr-auth)

5807 THE RADIOACTIVATION ANALYSIS OF SEMICONDUCTOR GRAPHITE FOR NITROGEN BY THE $^{14}\text{N}(p,\alpha)^{11}\text{C}$ REACTION. Nozaki, Tadashi (Inst. of Physical and Chemical Research, Saitama, Japan); Okuo, Takayasu; Akutsu, Hiroyuki; Furukawa, Michiaki. *Bull. Chem. Soc. Jap.*, 39: 2685-90 (Dec. 1966).

The excitation curve for the $^{14}\text{N}(p,\alpha)^{11}\text{C}$ reaction was measured up to a proton energy of 15 MeV; the reaction was found to have a fairly high cross section for a sensitive determination of nitrogen by radioactivation. A convenient technique was developed for the rapid quantitative conversion of the irradiated graphite into carbonate within a closed system. This technique makes possible the determination of a trace (down to several ppB) of nitrogen in pyrolytic graphite. Discussions of the possible interference (i.e., that of boron by the $^{11}\text{B}(p,n)^{11}\text{C}$ reaction) are also given. The nitrogen content of the pyrolytic graphite sample was found to vary markedly according to the starting material and to the preparation conditions. (auth)

12320 DETERMINATION OF SOME LIGHT ELEMENTS BY SECONDARY REACTIONS. Aumann, D. C.; Born, H. J. (Technische Hochschule, Munich). pp 265-71 of *Proceedings of 1965 International Conference on Modern Trends in Activation Analysis*. College Station, Tex., Texas A and M Univ., 1965.

A short review is given of the sources of the secondary particles and of the advantages and disadvantages of the activation by secondary reactions. A method was developed for the determination of ^{18}O in hydrogen-containing substances by the secondary reaction $^{18}\text{O}(p,n)^{18}\text{F}$ induced by recoil protons. The reaction chain $^6\text{Li}(n,\alpha)^3\text{H}$, $^{18}\text{O}(t,n)^{18}\text{F}$ was made the basis of a method of detection of lithium in a variety of substances and of detection of oxygen in metal-organic compounds, organic solvents, and monomers. It is also shown that the matrix-effect, which appears in activation analysis with secondary reactions, can be compensated in most cases by calculated factors containing the different ranges of the charged particles and the different atomic densities of sample and standard. (auth)

12330 OXYGEN DETERMINATION USING TRITON ACTIVATION. De Goel, J. J. M.; Houtman, J. P. W. (Reactor Inst., Delft, Netherlands). pp 372-9 of *Proceedings of 1965 International Conference on Modern Trends in Activation Analysis*. College Station, Tex., Texas A and M Univ., 1965.

The use of the $^{18}\text{O}(t,n)^{18}\text{F}$ reaction for the determination of oxygen was investigated. The limited depth of penetration of tritons, which were formed during irradiation in the reactor from the lithium added to the sample by the (n,α) reaction, made the determination of oxygen concentrations in surface layers possible. Examples of the need for this type of determination can be found in metallurgy, where the thickness and composition of oxide layers are not always easily measured in other ways, or where a boundary layer with different oxygen content as a result of oxygen diffusion can influence certain properties of the metals. Other possible applications can be found in the investigation of plastic film, particularly of their surface oxidation or the extent of diffusion of

oxygen-containing plasticizers. Factors influencing the sensitivity and accuracy of the determination are: the stopping power for tritons of the materials in which the oxygen is to be determined; the homogeneity and reproducibility of the triton flux; the recoil of the ^{18}F formed; the natural oxygen content of the lithium compound; the contact area between lithium and oxygen-containing compounds; and interferences with other reactions. Attention was focused on the analysis of foils, covered with lithium-containing films, and powders in a mechanical mixture with a lithium compound. (D.H.M.)

14857 (AECL-2350) TRANSPORT OF OXYGEN IN OXIDE FILMS ON ZIRCONIUM DETERMINED BY THE NUCLEAR REACTION $^{17}\text{O}(\text{He},\alpha)^{16}\text{O}$. Cox, B.; Roy, C. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1965. 30p. (CONF-651017-4). Dep. AECL \$1.00

From Electrochemical Society Meeting, Buffalo.

By irradiation of Zr specimens oxidized wholly or partially in 50% ^{17}O with ^4He ions and by measuring the α -particles emitted from the $^{17}\text{O}(\text{He},\alpha)^{16}\text{O}$ reaction as a function of energy, it was possible to determine the concentration of ^{17}O as a function of depth in the Zr and its oxide. Experiments in which oxide films grown in ^{18}O were subsequently heated in 50% ^{17}O at 400 or 500°C and those in which Zr layers were evaporated onto the surface of films formed in ^{18}O , oxidized briefly in 50% ^{17}O at 400 or 500°C, and then were heated in vacuum at the same temperature, permitted a study of O_2 transport in growing oxide films directly, without invoking any assumptions about the mechanism of oxidation. Results showed that the concentration of ^{17}O close to the surface never attains more than a small fraction of the saturation value, and that the logarithm of the concentration at any point below the surface decreased approximately linearly with increasing depth; however, the results also gave a straight line on a probability plot. It was concluded that the observed transport of O_2 may be by a line diffusion process, (via crystallite boundaries in the oxide) with lattice diffusion so slow that it is not observed at 500°C or below by this technique; alternatively the transport of O_2 may be controlled by some barrier close to the surface of the oxide, with the observed distribution being the result of lattice diffusion. It has not been possible, from the evidence obtained, to distinguish between the two possibilities. Diffusion coefficients in Zr have been determined from the distribution of O_2 in the metal, below the oxide film, on samples which had porous oxides (permitting easy access of oxygen to the metal oxide interface). The results suggest that a line diffusion process, where transport is along grain boundaries or dislocations, controls O_2 penetration into the metal at temperatures below 600°C. (auth)

Neutron

12311 FAST-NEUTRON ACTIVATION ANALYSIS SYSTEM WITH INDUSTRIAL APPLICATIONS. Wood, J. D. L. H. (Services Electronics Research Lab., Hertfordshire, Eng.); Downton, D. W.; Bakes, J. M. pp 175-81 of *Proceedings of 1965 International Conference on Modern Trends in Activation Analysis*. College Station, Tex., Texas A and M Univ., 1965.

An activation analysis system is described which centers around a sealed-off neutron tube with an output of 10^{10} 14 MeV n/sec and employs fast pneumatic sample transfer and gamma spectrometry. Nuclides with half-lives in the range of a few seconds up to several hours may be employed in this system as neutron output is essentially constant for at least 100 hr. The concentration of oxygen in steel down to the 10 ppm level in 10 g samples was measured, and the suitability of the system for industrial use at the sampling rate of 600 samples per day is discussed. Concentrations of major mineral constituents were studied. Oxygen, silicon, and aluminum were determined to an accuracy of 2% in $\frac{1}{2}$ g samples. The extension of the technique to other elements by purely instrumental methods without recourse to chemical separation is discussed. (auth)

19575 PROBLEMS OF CHANGE IN NEUTRON FLUX IN A SAMPLE IN ACTIVATION ANALYSIS. Rakovic, Milosav; Prouza, Zdenek (Charles Univ., Prague). *Chem. Listy*, 60: 1496-1508 (Nov. 1966). (In Czech).

The effects of self-absorption, hardening and moderation on the neutron flux in activation analysis were studied both experimentally and theoretically. Thirty-two references are reviewed, which show possible ways of evaluating or eliminating such errors. One method is to use an internal standard. Another is to use a calibration curve or to calculate the error from an equation. Such an equation is derived, in which terms appear for the ratio of the fraction of the total neutron flux in the sample to the total flux and the effective resonance integral. Standard nuclear constants are used for the calculation, i.e., cross sections from known tabulated values. (TTT)

15874 NEUTRONOAKTIVATSIONNYI ANALIZ. (Neutron Activation Analysis). Breslav, V. I. (ed.). Riga, Izdatel'stvo Zinatne, 1966. 148p.

Fourteen articles are included on the problems and methods of activation analysis in physics, chemistry, and biology. The first four articles include data on scintillation gamma spectra for rare earth radioisotopes, analysis of spectral problems of activation analysis related to the sensitivity criterion of the method, effects of neutron flux reduction in the specimen, and the feasibility of oxygen determination by means of reactor neutrons. The remaining articles discuss concrete methods of neutron activation analysis, including gamma spectra of short-lived isotopes produced in a reactor and an activation method for measuring large doses and fluxes of gamma emission. Neutron activation methods for the rapid determination of micro-impurities of Dy and Sm in Y_2O_3 , determination of Al, Na, Mn, Sb, Cu, and As in LiF, and determination of Cu, Mn, and Zn in human hair and in blood serums are described. (R.V.J.)

5784 DETERMINATION OF THE QUANTITY OF TWO ELEMENTS CONTAINED IN A MATERIAL BY NEUTRON ACTIVATION ANALYSIS, WHEN THERE IS A SMALL DIFFERENCE IN THEIR HALF LIVES. Agelao, G.; Dardanoni, Z. Tesaro (Univ., Palermo, Italy). Atti Accad. Sci., Lettere Arti Palermo, Pt. 1, 24: 85-94(1963/64). (In Italian).

An investigation was made of the determination by activation analysis of the ratio of two elements mixed in a single sample, in a special case. When the half-lives of the two radioisotopes in the mixture are only a little different, the graphic method applied to the decay curve plotted on semi-log paper appears inadequate. When the isotope having the shorter life has completely decayed, the activity of the longer-lived isotope is also reduced. Therefore, the last part of the curve is formed by scanty and uncertain points. A calculation method was studied, which is considered more reliable. (auth)

8203 INVESTIGATIONS OF SOME MOTOR-OIL ADDITIVES BY NEUTRON ACTIVATION. Nagy, L. G.; Szokolyi, L. (Polytechnical Univ., Budapest). Periodica Polytech., 8: No. 1, 41-62 (1964).

A comparison was made of the neutron activation determinations of elements commonly present in motor-oil additives, Ba, P, S, and Zn. These elements can be detected easily by comparing the irradiated oil and suitable standards by γ spectroscopy, or by measuring β or γ absorption or the half-lives of the radioisotopes produced. Results are tabulated. (Analytical Abstr.)

19537 (MG/D-329/65) FAST-NEUTRON REACTIONS AND THEIR POSSIBLE APPLICATION TO THE ACTIVATION ANALYSIS OF STEELWORKS MATERIAL. Scholes, P. H. (British Iron and Steel Research Association, Sheffield (England)). Nov. 1965. 16p. Dep. mn.

Supersedes MG/D-369/64.

The use of fast neutron generators in conjunction with gamma spectrometers for the direct analysis of steelworks material without the need for chemical separations is discussed. Available fast neutron reactions are listed for elements present in iron, steel, slags and iron ores. Principal interference effects are noted and possible applications discussed. (UKAEA)

4460 USE OF RADIOACTIVATION ANALYSIS FOR COPPER DETERMINATION IN VINE-GROWING AND IN VINE-PRODUCTS. Fourcy, A.; Dognin, J.; Faure, J.; Neuburger, M. (Centre d'Etudes Nucleaires, Grenoble, France). Int. J. Appl. Radiat. Isotopes, 17: 629-36 (Dec. 1966). (In French).

Radioactivation analysis was used for the determination of trace-element and pesticide copper in vines. The amounts of copper present in the samples analyzed varied from 0.1 to 1000 μ g. Two methods were used. The first one is for trace analysis and includes a radiochemical separation of copper, the other one is applicable to amounts above 100 ppM and is a purely instrumental method without chemistry. (J.G.B.)

4451 DETERMINATION OF OXYGEN IN ALUMINUM BY A FAST NEUTRON ACTIVATION METHOD. Fujii, Isao (Toshiba Central Research Lab., Kawasaki, Japan); Takada, Koichi; Muto, Haruo. Bunseki Kagaku, 15: 1239-45 (Nov. 1966). (In Japanese).

A fast neutron activation method was applied to the determination of oxygen in aluminum and its alloys. A pre-treatment method of sample surface before analysis, optimum conditions on the measurement of gamma rays from ^{16}N , and a correction method for the absorption of neutrons, beta rays, and gamma rays in the sample are discussed. The samples including oxygen of the order of 10 to 0.0008% were analyzed by the proposed method. Relative standard deviations of the method in the oxygen levels of 0.1, 0.01, and 0.001% were 3, 5, and 30%, respectively. The sensitivity obtained was 2000 counts/mg of oxygen. (auth)

4462 QUICK DETERMINATION OF OXYGEN IN STEEL BY FAST NEUTRON ACTIVATION. Shimura, Kazuteru (Fujii Iron and Steel Co., Ltd., Japan); Fujii, Isao. Tetsu To Hagane, 51: No. 11, 2178-80 (Oct. 1965). (In Japanese).

Oxygen was determined in steel by activation analysis, and the result was compared with the value obtained by the vacuum fusion method. The time required for the determination was about one minute. The experimental results obtained by both methods were nearly the same. In the range of oxygen content 0.01 to 0.2%, the deviation was ± 3 to 5% for forty measurements. The statistical deviation, at low oxygen contents, was inevitably somewhat large, but this may be reduced by improving the apparatus. In the sample preparation, cutting off a sample specimen after surface polishing gave a higher reliability in the measured value although it was more time-consuming. (NSA of Japan)

10292 DETERMINATION OF OXYGEN IN MOLYBDENUM BY ACTIVATION WITH FAST NEUTRONS. Andreev, A. V.; Barit, I. Ya.; Musaelyan, R. M.; Pronman, I. M. Zh. Anal. Khim., 21: 1453-6 (1966). (In Russian).

The method of determining oxygen by activation with fast neutrons is one of the most rapid of all the methods known. One determination takes 15 to 20 min. The process of analysis can be completely automatized. The sensitivity of the method is $1 \times 10^{-8}\%$; the accuracy is $\pm 30\%$. (auth)

1275 USE OF FAST REACTOR NEUTRONS FOR RAPID AND NONDESTRUCTIVE TRACE ANALYSIS, ESPECIALLY OF OXYGEN. Aumann, D. C.; Born, H. J.; Henkelmann, R. (Technische Hochschule, Munich). Z. Anal. Chem., 221: 101-8 (1966). (In German).

The intense fast-neutron fluxes, which are available in nuclear reactors, can be used for rapid and nondestructive activation analysis of many elements. Some elements have superior detection limits for activation with fast reactor neutrons compared to reactor thermal-neutron activation. Short-lived radionuclides can be measured using a fast pneumatic tube system. Oxygen can be determined by the nuclear reaction $^{16}O(n,p)^{16}N$ initiated by fast reactor neutrons counting the high-energy gamma rays of the 7.4-sec ^{16}N . The method is suitable for determining as little as 10 ppM of oxygen in many types of analytical samples. The fast transfer system, which is used in the Munich research reactor for rapid and nondestructive activation analysis, is described. The use of the transfer system for oxygen activation analysis and problems associated with oxygen analysis are discussed. (auth)

10272 A CRITICAL REVIEW OF NEUTRON ACTIVATION AND TRACER METHODS FOR THE DETERMINATION OF THE NOBLE METALS. Beamish, F. E.; Chung, K. S.; Chow, A. (Univ. of Toronto). Talanta, 14: 1-32 (1967).

Neutron activation methods for seven noble metals (Au, Ru, Os, Rh, Ir, Pd, Pt) are critically reviewed. The methods deal with determination of trace impurities in each noble metal, as well as traces of noble metals in media such as organic material, fission products, and other solutions, ores, alloys, minerals, silica and base metals. The need for confirmatory evidence in the case of such complex materials as ores is emphasized. (auth)

12342 EXPERIMENTAL EVALUATION OF NEUTRON ACTIVATION, WET ASSAY, AND FIRE ASSAY METHODS OF DETERMINING GOLD IN ORES. Chow, A.; Beamish, F. E. (Univ. of Toronto). Talanta, 14: 219-31 (Feb. 1967).

Errors associated with fire-assay, wet-extraction, and neutron-activation methods were evaluated; the accuracy and precision of these methods were compared and a method of determining chemical recovery in the activation determination of gold in ores and concentrates is presented. (auth)

1261 DETECTION OF OXYGEN IN METALS, PARTICULARLY IN STEEL, BY ACTIVATION ANALYSIS WITH 14.5-MeV NEUTRONS. Schramel, P.; Muenzer, H. (Institut fuer Radiumforschung und Kernphysik, Vienna). Acta Phys. Austr., 23: 266-71 (1966). (In German).

A method for the activation analysis of O_2 in metals, particularly steel, is outlined. The interfering reactions and corrections that must be made in compensation are given. The method is valid to O_2 contents of 25 ppM. The relative error at O_2 concentrations under 20 ppM is approximately 15%. The method is suitable for routine measurements. (J.S.R.)

8210 POSSIBILITY OF ELEMENTAL ANALYSIS BY USE OF NEUTRON-CAPTURE γ -RAYS DUE TO NEUTRONS FROM LOW-LEVEL SOURCES. Okada, Minoru. Tokyo Kogyo Shikensho Hokoku, 61: 448-55 (Oct. 1966). (In Japanese).

An outline of an improved device using 50- and 250-mCi radium-beryllium neutron source together with water and paraffin, respectively, is presented for possible detection of capture γ rays of Gd, Sm, Cd, Dy, Cl, Co, Ag, Sc, Mn, Se, N, Ti, Ni, and Cr. As far as a low-level neutron source is used a high sensitivity and a rapid method will not be realized in the elemental analysis of this kind. (auth)

5789 NEUTRON-ACTIVATION DETERMINATION OF SILVER IN ORES AND ROCKS. Stefanov, G.; Nenov, N.; Zhikov, Z.; Mihailov, M.; Popov, Ch.; Georgiev, N.; Tomov, T. G.; Toelgyessy, J. (Geological Research Inst., Sofia). *Compt. Rend. Acad. Bulg. Sci.*, 18: 425-8(1965).

The sample and standard were irradiated for 50 hr in a thermal-neutron flux of $\approx 5.4 \times 10^{11}$ neutrons per cm^2 per sec, allowed to decay for 2 days, then fused, together with a carrier, with a 5-fold amount of Na_2O_2 . After a relatively short chemical treatment of the melt, the Ag was precipitated and weighed as AgCl. The activity of the 0.656-MeV γ peak was measured in a 400-channel pulse-height analyzer. The method is sensitive to $\approx 2 \times 10^{-7}$ g of Ag. (Analytical Abstr.)

5783 ACTIVATION ANALYSIS: RAPID DETERMINATION OF GOLD IN SEA WATER. Cappadona, Carmelo (Univ., Palermo, Italy). *Atti Accad. Sci., Lettere Arti Palermo*, Pt. 1, 24: 71-4(1963/64). (In Italian).

Gold determination in seawater by activation analysis using a low neutron flux is suggested. The gold is separated with a carrier in the metallic state without radioactive impurity and with good yield. (M.C.G.)

8217 QUANTITATIVE ACTIVATION ANALYSIS FOR TRACES OF GOLD IN URANIUM MINERALS. Galiano Sedano, J. A.; Travesi Jimenez, A. (Junta de Energia Nuclear, Madrid). *An. Real Soc. Espan. Fis. Quim. (Madrid)*, Ser. B, 62: 1119-28 (Nov. 1966). (In Spanish).

Neutron activation analysis was used to determine traces of gold in uranium ores. The method is based on the addition of isotopic gold carrier to the irradiated ore samples, followed by dissolution, radiochemical separation, and 5×10^{11} nV which permits the determination of as little as 2×10^{-8} grams of gold. The radiochemical purity of the gold precipitate is checked by gamma spectrometry with a scintillation crystal of NaI(Tl) and a multichannel analyzer. (P.C.H.)

2982 NON-DESTRUCTIVE ANALYSIS OF ANCIENT SILVER COINS. Das, H. A.; Zonderhuis, J. (Reactor Centrum Nederland, Petten, Netherlands). *Rec. Trav. Chim.*, 85: 837-41(Aug. 1966).

The methods of specific gravity, thermal neutron activation, and x-ray fluorescence were applied to the nondestructive analysis of 34 silver coins from Sicily. According to the dimensions and weights, the coins could be divided into six groups. The results of the Ag, Cu, Pb, and Au analyses are given in tabular form for the six groups. (B.L.M.)

2940 DETERMINATION OF TRACE SILVER IN HIGH-PURITY ZINC BY NEUTRON ACTIVATION. Mousty, F.; Fournage, J.; Duyckaerts, G. (Univ., Liege). *Anal. Chim. Acta*, 36: 478-88(Dec. 1966). (In French).

Below the ppm level, the determination of silver in zinc by non-destructive γ spectrometry is no longer feasible due to the activation of the matrix element. The activated zinc is dissolved in nitric acid, sulfamic acid and silver carrier are added, and ^{110m}Ag (253 d) is obtained in a radiochemically pure state after two successive electrolyses on gold cathodes. After two days of irradiation in a thermal neutron flux of the order of 3×10^{13} n/cm² sec, 30 mg of silver can easily be evaluated with an error of 5%. Data obtained by integral γ counting or by γ spectrometry are compared. (auth)

12367 PURITY CONTROL OF "SIX-NINE" LEAD BY NEUTRON ACTIVATION ANALYSIS. PART I. DETERMINATION OF GOLD, SILVER, ARSENIC, GERMANIUM, ANTIMONY, TIN, AND BISMUTH. Bianchini, A.; Lanfranco, G. (Centro Ricerche Metallurgiche, Turin). *Chim. Ind. (Milan)*, 48: 816-23(Aug. 1966). (In Italian).

A method is described in which inverted isotopic dilution is used for determining impurities in high-purity (99.9999%) Pb. After neutron irradiation the sample is attacked with nitric acid; during this treatment carrier solutions of the elements to be determined are added. Au, Ag, As, Ge, Sb, Sn, and Bi are separated in different chemical forms, and are thoroughly purified. The extent of recovery after the separation is established by chemical determination. Beta activity of radionuclides thus separated is measured with a front-window G-M counter; γ activity is measured with a NaI(Tl) scintillation detector and a pulse-height, single-channel analyzer. Quantitative determination is made by comparison with the activity of a known amount of the analyzed element, irradiated together with the sample being tested. The equipment required is inexpensive; the method is simple, sensitive, and fairly accurate. (BBB)

12370 PURITY CONTROL OF "SIX-NINE" LEAD BY NEUTRON ACTIVATION ANALYSIS. PART II. DETERMINATION OF COPPER, CADMIUM, COBALT, IRON, GALLIUM, INDIUM, NICKEL, AND ZINC. Bianchini, A.; Lanfranco, G. (Centro Ricerche Metallurgiche, Turin). *Chim. Ind. (Milan)*, 48: 823-9(Aug. 1966). (In Italian).

The method, which is described, is the same as that reported in Part I of this series for neutron activation analysis of Pb which is 99.9999% pure. Following neutron irradiation, the sample is treated with nitric acid and carrier solutions are added of the elements to be determined. Cu, Cd, Co, Fe, Ga, In, Ni, and Zn are separated in various chemical forms, and thoroughly purified. Methods involving chemical determinations are used for establishing the effectiveness of the separation of these elements. The β activity of radionuclides thus separated is measured with a G-M counter; γ activity is measured with a NaI(Tl) scintillation detector, and a pulse-height single-channel analyzer. Quantitative determination is made by comparison with the activity of a standard amount of the analyzed element irradiated together with the sample. Advantages of the method are discussed. (BBB)

19579 DETERMINATION OF FLUORINE IN FLUORITE ORES AND CONCENTRATES BY ISOTOPE-SOURCE FAST-NEUTRON ACTIVATION ANALYSIS. Jeffery, P. G.; Bakes, J. M. (Ministry of Tech., Stevenage, Eng.). *Analyst*, 92: 151-5(Mar. 1967).

The fluorine contents of fluorite ores and concentrates were determined by activation analysis. No sample preparation, other than crushing and grinding, was required. Sources employed were Th-Be and Am-Be. (UK)

19541 DETERMINATION OF FLUORITE BY ACTIVATION ANALYSIS IN ORE SAMPLES AND CONCENTRATION PRODUCTS. Prokopchik, V. I.; Subbotina, T. I. *At. Energ. (USSR)*, 21: 415-17(Nov. 1966). (In Russian).

A field apparatus for the activation determination of fluorite in ore samples and concentrates was described. Comparison with chemical analysis shows that activation determination of fluorite is less precise than chemical determination, but speed of the activation method is much greater. (J.S.R.)

10262 DETERMINATION OF FLUORITE BY ACTIVATION ANALYSIS. Bushkov, A. P.; Prokopchik, V. I. *At. Energ. (USSR)*, 21: 215-17(Sept. 1966). (In Russian).

The activation method is widely used to determine the CaF_2 content of ores; in most cases a fast-neutron source is used for the analysis. The activation is due to fast-neutron threshold reactions and to (n, γ) reactions of thermal neutrons formed by the slowing down of the fast neutrons. Calculation of the spatial distribution of the source in an infinite, hydrogen-free medium indicated that at 20 cm from the source, the >3 -MeV fast flux exceeds the thermal flux. The effective cross section of the $^{19}\text{F}(n, \alpha)^{16}\text{N}$ fast-neutron reaction exceeds that of the $^{19}\text{F}(n, p)^{18}\text{O}$ and $^{19}\text{F}(n, \gamma)^{20}\text{F}$ thermal-neutron reactions; therefore, it was assumed that the γ radiation observed is induced by fast neutrons. This problem was experimentally investigated on a mock-up, using a 5.4×10^6 n/cm² Po-Be source. Although the results did not allow definite conclusions to be drawn, it appeared that the γ radiation of ^{16}N played the most important role; activation by thermal neutrons was slight. (TTT)

12371 STUDY OF 14-MeV NEUTRON-INDUCED REACTIONS FOR ANALYSIS OF TRACE FLUORIDES. Nargolwalla, Sam. Toronto, Univ. of Toronto, 1965.

Thesis.

Three general methods, adequately tested with practical examples, are discussed for the study of 14-MeV neutron-induced reactions for trace analysis of fluorides. The design and construction of a complete fast-activation facility associated with a 14-MeV neutron source are described. The flow method allows a rapid and continuous activation analysis of fluorides in liquid streams. Fluoride concentrations as low as one ppm with a precision of 10% can be measured using a comparison activation technique. The procedure involves analysis of suitably discriminated gamma spectra generated from the induced $^{19}\text{F}(n, p)^{18}\text{O}$ reaction with two $2'' \times 2''$ NaI detector-single channel analyzer systems. A significant feature of the apparatus is the design and arrangement of an efficient twin-flow liquid irradiation assembly. Under optimum experimental conditions, it was established that the concentrations of interfering elements in drinking water yielding the same counting rate as one ppm of fluoride were: nitrogen, 200 ppm; silicon, 15 ppm; oxygen, $\sim 10^6$ ppm; sulfur, $>10^3$ ppm; sodium, 90 ppm; chlorine, $>10^3$ ppm; magnesium, 330 ppm; potassium, $>10^3$ ppm; and aluminum,

50 ppm. In addition, a method of measuring and correcting for the inherent interference from ^{13}N produced by recoil proton reactions with oxygen in aqueous media is also presented. This flow method is found to be successful with abnormally hard water samples.

The second method includes an ion-exchange concentration step prior to activation analysis. The fluoride-resin matrix is transported rapidly in a specially designed pneumatic transfer system to the counting area where, by suitable scintillation spectrometry using a $3'' \times 3''$ NaI detector-400 channel analyzer, the fluoride activity is determined. Sensitivities using $^{18}\text{F}(n,p)^{18}\text{O}$ and $^{19}\text{F}(n,2n)^{18}\text{F}$ reactions of 25000 ppm and 1600 ppm respectively are reported. Analysis time for a single determination varies from 2 to 6 hr. The third method, which consists of irradiating fluoride in a distilled water matrix, gives a sensitivity of 200 ppm fluoride. The procedure takes about 4 hr and includes a gross decay analysis with a $1\frac{3}{4}'' \times 2''$ well-type NaI scintillation counter. The fluoride content of a tea sample analyzed by this method is reported. In addition to possible applications for fluoride analyses in other media, this investigation demonstrates the potential advantages of fast-neutron activation analysis of flow systems. (Dissertation Abstr.)

12362 DETERMINATION OF IMPURITIES IN IRON BY NEUTRON ACTIVATION METHOD. Artyukhin, P. I.; Gil'bert, E. N.; Pronin, V. A. (Inst. of Inorganic Chemistry, Academy of Sciences, Novosibirsk, USSR). *Zh. Anal. Khim.*, 22: 111-13(Jan. 1967). (In Russian).

A method was investigated for the radioactivation determination of Co, Cu, In, Zn, As, Te, and Sn as microimpurities in iron of high purity. After radioactivation of the sample, iron was separated by extraction with β, β' -dichlorodiethyl ether from concentrated hydrochloric acid. Impurities which remained in the aqueous phase were separated on the Dowex 1 anion exchanger in the F^- form into two groups: Co, Cu, In, Zn; and As, Te, Sn. The elements of the first group were determined γ spectrometrically without any further separation. The elements of the second group were separated on the Dowex 1 resin in the Cl^- form. The quantitative determination of microimpurities was carried out by comparing the activity separated from the sample with that of the corresponding standard. (auth)

8199 NEUTRON-ACTIVATION ASSAY FOR LANTHANUM AND SAMARIUM IN MINERALS. Babaev, A.; Lobanov, E. M. *Dokl. Akad. Nauk Tadzh. SSR*, 6: No. 6, 12-17(1963). (In Russian).

Samples of monazite, orthite, davidite, and euxenite, together with La and Sm standards, were irradiated in a neutron flux of $\approx 1.2 \times 10^{12}$ thermal neutrons per cm^2 per sec for 10 min. The induced radioactivity due to ^{140}La and ^{153}Sm was measured with a scintillation spectrometer, with a NaI(Tl) detector crystal. (Analytical Abstr.)

8221 DETERMINATION OF CESIUM TRACES IN MINERAL SALTS BY MEANS OF NEUTRON ACTIVATION-ION EXCHANGE CHROMATOGRAPHY METHOD. Sterlinski, Slawomir; Dyczynski, Rajmund (Inst. of Nuclear Research, Warsaw). *Nukleonika*, 11: 533-53(1966).

A neutron activation-chromatographic method for the determination of traces of cesium that makes use of the short-lived isomer $^{134\text{m}}\text{Cs}$ is presented. Cesium was isolated from macro amounts (0.5 g sample) of lighter alkali metals on the column with MK-3 cation exchanger (phenolsulfonic resin) before irradiation. After irradiation this cesium fraction was further purified from interfering activities by multistep ion exchange chromatography on micro-columns involving both cation and anion exchangers. The activity of the 31-keV photopeak was measured by gamma-spectrometric techniques using a very thin NaI(Tl) crystal. The precision of the method (defined in terms of three standard deviations) was better than 12%. The sensitivity amounted to 4×10^{-11} g Cs, i.e., $8 \times 10^{-9}\%$. The method was shown to be fully applicable to the analysis of various mineral salts. (auth)

8195 ACTIVATION ANALYSIS OF SHORT-LIVED ISOTOPES: STUDY OF THE NONDESTRUCTIVE DETERMINATION OF HAFNIUM ($^{178\text{m}}\text{Hf}$, $T = 19\text{s}$) AND ITS APPLICATIONS. Haerdi, W.; Balsenc, L.; Monnier, D. (Univ., Geneva). *Chimia (Aarau)*, 20: 429-30(Dec. 15, 1966). (In French).

A method is described for radiochemical assay of hafnium based on the formation of $^{178\text{m}}\text{Hf}$ (and $^{178\text{m}}\text{Hf}$) after activation with thermal neutrons. The interferences due to aluminum, iron, and many other metals were studied. A method is described for the direct assay (without dissolution or separation) of Hf in zirconium salts, metallic zirconium, and Zircaloy. (auth)

14160 THE DETERMINATION OF ANTIMONY, CADMIUM, CERIUM, IRIDIUM, AND SILVER IN BIOLOGICAL MATERIAL BY RADIOACTIVATION. Bowen, H. J. M. (Univ. of Reading, Eng.). *Analyst*, 92: 118-23(Feb. 1967).

A method for determining antimony, cadmium, cerium, iridium, and silver simultaneously in a sample of biological material is described. The method involves radioactivation to long-lived radionuclides by using thermal neutrons from a reactor, and has a high sensitivity. (auth)

15849 DETERMINATION OF ALUMINUM AND SODIUM IN TUNGSTEN BY NONDESTRUCTIVE ACTIVATION ANALYSIS. Quittner, P.; Simonits, A.; Elek, A. (Central Research Inst. for Physics, Budapest). *Talanta*, 14: 417-20(Mar. 1967).

The sodium and aluminum content of tungsten was measured by thermal neutron activation analysis. The concentration of aluminum was evaluated from the 1.78 MeV and that of sodium from the 2.76 MeV full energy peaks. The minimum detectable concentrations of these impurities were 0.04 μg of aluminum and 0.07 μg of sodium per 100 mg of tungsten. (auth)

5780 THE DETERMINATION OF COPPER IN ZINC MATERIALS BY NEUTRON ACTIVATION ANALYSIS USING THE $^{65}\text{Cu}(n,\gamma)^{66}\text{Cu}$ REACTION. Tomura, Kenji; Higuuchi, Hidco (Rikkyo Univ., Yokosuka, Japan). *Anal. Chim. Acta*, 37: 33-41(Jan. 1967).

The nondestructive and destructive determinations of copper in zinc materials by neutron activation using $^{65}\text{Cu}(n,\gamma)^{66}\text{Cu}$ reaction are described. Observed cross sections of $^{64}\text{Zn}(n,p)^{64}\text{Cu}$ and $^{66}\text{Zn}(n,p)^{66}\text{Cu}$ reactions for fission spectrum neutrons were 28 and 0.51 mb respectively. A double irradiation technique with one sample wrapped in cadmium foil and another bare, was employed for the correction of concurrent formation of ^{66}Cu by (n,p) reaction. One hundred ppm of copper in zinc sulfide was determined nondestructively by γ spectrometry using a thermal flux of 5×10^{11} n/cm 2 /sec, while 0.5 ppm of copper in zinc was determined by a thermal flux of 2.5×10^{10} n/cm 2 /sec, and by a rapid chemical separation involving copper(I) thiocyanate precipitation. The proposed activation procedures were compared with the spectrophotometric dibenzylthiocarbamate procedure. (auth)

12310 DETERMINATION OF INDIUM AND THALLIUM IN ZINC AND ZINC SALTS. Gibbons, D.; Lawson, D. (United Kingdom Atomic Energy Authority, Wantage, Eng.). pp 173-4 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Indium and thallium were determined in zinc metal by neutron activation analysis. The indium content was found nondestructively via 54 min $^{115\text{m}}\text{In}$ measuring the 1.27-MeV photopeak by gamma spectrometry. The decay of this photopeak was also used as a further means of discrimination. The samples were subsequently reirradiated and the thallium content measured via radiochemical purification of ^{204}Tl , the purity of the radioactivity being confirmed by beta-absorption measurements and decay studies. The method was applied to the analysis of zinc doped with indium and thallium and the results compared with those obtained spectrographically and polarographically. The method was subsequently applied to the analysis of zinc metal and zinc salts. The interference of zinc in the gamma spectrometry of indium is discussed together with the effects of varying irradiation and decay times. (auth)

14157 DETERMINATION OF SELENIUM IN STANDARD ROCKS BY NEUTRON ACTIVATION ANALYSIS. Brunfelt, A. O. (Oslo Univ.); Steinnes, E. *Geochim. Cosmochim. Acta*, 31: 283-5(Feb. 1967).

Selenium concentrations in terrestrial rocks were determined by distillation with HCl/HBr as a specific separation method, followed by neutron activation analysis based on 120d ^{76}Se . The mean values given are probably accurate to $\pm 10\%$ for concentrations above 0.02 ppm and to $\pm 20\%$ for lower concentrations. The sensitivity for detection of Se is 0.0005 μg . (INIS-UK)

5811 NEUTRON ACTIVATION ANALYSIS OF THORIUM IN NATURAL WATERS. Osawa, Masumi; Tokunaga, Okhiro (Japan Atomic Energy Research Inst., Tokyo). *J. Nucl. Sci. Technol. (Tokyo)*, 3: 333-42(Aug. 1966).

Neutron activation analysis of Th in mineral springs and coastal waters is reported. After preliminary concentration of Th in natural waters with coprecipitation of ferric hydroxide, the samples were irradiated in JRR-2. The ^{233}Pa produced in the target materials was radiochemically separated by solvent extraction using a hydrochloric acid system, and the electrodeposited source was counted. The chemical yield was verified by ^{231}Pa tracer. The reliability of this method was ascertained by the use of standard rock

G-1. Values of 0.01 to 0.5 $\mu\text{g/l}$ were obtained for Th content in waters from several springs in Japan. These values were much lower than those previously reported, and the characteristics varying with region are reported. Some geochemical considerations with regard to the origin of U in the springs of such localities as Asanbara and Misasa are discussed. (NSA of Japan)

6088 APPLICATION OF NEUTRON ACTIVATION ANALYSIS FOR THE INVESTIGATION OF ROCKS OF MANGANESE CONTENT. Beress, M. *Geofiz. Kozlem.*, 15: 181-94(1966). (In Hungarian).

By the use of neutron activation analysis, a new method was created for the simultaneous nondestructive determination of manganese, aluminum, and silicon content in samples of rocks with an accuracy meeting industrial requirements. In the portable activation system, powdered samples of rocks of 38 g weight were simultaneously irradiated in fields of slow and fast neutrons for 4.6 minutes by the help of a polonium-beryllium source of neutrons having an intensity of 7 curies. The concentrations were computed from the pulse number measured in the intervals of 0.4 to 5.4 and 60 to 65 minutes after the irradiation was finished. The described method permits also a more accurate determination of manganese content, occasionally for drawing geochemical conclusions; in this instance, however, one must dispense with the analysis of aluminum and silicon content together with that of manganese since, in the case of more accurate manganese determination, it is necessary to prolong the duration of exposition that results in the domination of pulse number due to the isotope ^{56}Mn . The practical applicability of this method is demonstrated on a complete well log. (auth)

4448 MICROANALYSIS USED FOR METEORITES. Duval, Clement (Laboratoire de Recherches Micro-Analytiques, Paris). *Chim. Anal. (Paris)*, 48: 537-48(Oct. 1966). (In French).

Results of determinations of the lesser components found in meteorites are given and some generalities, description, frequency of fall, and classification of meteorites discussed. The data were obtained by mass spectrography, the dilution method, and neutron activation. (auth)

19580 ABUNDANCE OF MERCURY IN METEORITES AND ROCKS BY NEUTRON ACTIVATION ANALYSIS. Ehmman, William D.; Lovering, John F. (Australian National Univ., Canberra). *Geochim. Cosmochim. Acta*, 31: 357-76(Mar. 1967).

Mercury abundances were determined in all classes of chondritic meteorites, the principal classes of achondritic meteorites, alkali and tholeiitic basalts, differentiated tholeiitic basalt intrusions, possible lower crustal and upper mantle rock inclusions, and a collection of six standard crustal rocks using thermal neutron activation. Relatively high mercury abundances in the carbonaceous chondrites were confirmed. Abundance data among the various classes of chondrites and achondrites suggest a more complex behavior for mercury in the evolution of the

meteorites than previously proposed. Possible lower crustal or upper mantle materials exhibited high mercury abundances in the range of the basic achondrites while the six standard crustal rocks had abundances in the range of only 0.004 to 0.04 ppm. Implications of the data with respect to the estimation of cosmic abundances, and the evolution of the meteorites and the earth are discussed. (auth)

12366 QUANTITATIVE DETERMINATION OF MERCURY IN HAIR BY ACTIVATION ANALYSIS. Hoshino, Otomatsu (Tokyo Univ.); Ouchi, Atsuhiko. *Eisei Kagaku*, 12: 94-9(Apr. 1966). (In Japanese).

Activation analysis has been applied to the quantitative determination of Hg in human hair. Results of activation analysis are compared with the results obtained by the conventional colorimetric dithizone method. Results are reported for determinations on hair sampled from people in Japan and other countries. The distribution of Hg along the length of the long hairs obtained from "Minamata diseased" patients and their families in the Niigata prefecture were determined by the nondestructive method and are reported. (TSS)

10270 THE TRACE ELEMENT CONTENT OF HUMAN HEAD HAIR IN ENGLAND AND WALES AND THE APPLICATION TO FORENSIC SCIENCE. Coleman, R. F.; Cripps, F. H.; Stinson, A.; Scott, H. D. (Atomic Weapons Research Establishment, Aldermaston, Eng.). *Atom. No.* 123, 12-22(Jan. 1967).

One of the more frequent investigations in a forensic science

laboratory is concerned with the problem of determining whether a particular object can be shown to come from a specified source. Hair may be found at the scene of a crime and if it can be shown to be similar to the hair of a suspect, then it establishes a link between the suspect and the place or circumstance in which it was found. Trace element analysis can assist in associating hair with a particular head. Details of studies to enable a quantitative assessment to be made of the value of this approach in forensic examinations are presented. Emphasis is on the application of neutron activation analysis. (UK)

2941 SECOND-ORDER INTERFERENCE IN THE NEUTRON ACTIVATION ANALYSIS OF ARSENIC IN A GERMANIUM MATRIX. De Neve, R.; De Soete, D.; Hoste, J. (Ghent Univ.). *Anal. Chim. Acta*, 36: 508-14(Dec. 1966).

The second-order interference $^{74}\text{Ge}(n,\gamma;\beta^-; n,\gamma)^{76}\text{As}$ that occurs in the activation analysis of arsenic in a germanium matrix, using thermal neutrons was determined experimentally. A practical formula was derived, for irradiation times longer than 2 hr, which showed that the interference, expressed as an apparent arsenic concentration, is proportional to the neutron flux. Experiments were performed for irradiation times of 10, 15 and 20 hr at a neutron flux of 10^{14} n/cm²/sec, yielding apparent arsenic concentrations in the germanium matrix of respectively 223, 408, and 597 ppB. From these results a value of 0.48 ± 0.06 barn could be calculated for the activation cross section of ^{74}Ge for neutron capture. (auth)

18 STUDIES OF THE ABSORPTION CURVES OF VARIOUS MIXTURES OF ^{24}Na - ^{42}K FOR CONTROLLING RADIOCHEMICAL PURITY IN NEUTRON ACTIVATION ANALYSIS. Rakovic, Miloslav; Prochazkova, Z. (Charles Univ., Prague). *Chem. Zvesti*, 20: 538-44(1966). (In Czech).

Absorption curves for mixtures of ^{24}Na and ^{42}K were calculated for the cases in which the pulse rate (measured without filter) was caused chiefly by one radionuclide and the second participated only to 2, 4, 6, or 10% of the pulse rate. The effects of an aluminum filter were studied. The method makes it possible to control the impurities of ^{42}K in ^{24}Na and of ^{24}Na in ^{42}K . (M.C.G.)

12295 DETERMINATION OF TRACES OF ARSENIC IN GERMANIUM BY NEUTRON ACTIVATION ANALYSIS. De Soete, D.; De Neve, R.; Hoste, J. (Ghent Univ.). pp 31-8 of *Proceedings of 1965 International Conference on Modern Trends in Activation Analysis*. College Station, Tex., Texas A and M Univ., 1965.

Neutron activation analysis was used for determination of arsenic in germanium and germanium dioxide by gamma or beta spectrometry using ^{71}As as an internal standard. In the gamma-spectrometric technique the 1.21-MeV gamma of ^{76}As was measured against the 0.246-MeV gamma of ^{71}As . For arsenic concentrations higher than 30 ppm a Compton-compensated spectrometer was used and the content directly computed from the ratio of the photopeaks. This technique allowed determinations down to 50 ppB. Below this level beta spectrometry was preferred. The use of an absorber was required to avoid pile-up of the high-activity level of the beta radiation of ^{71}As . The lower limit for the arsenic determination was estimated at 10^{-8} g, i.e., 1 ppB for a 1-g sample. (auth)

1277 USE OF NEUTRON ACTIVATION ANALYSIS FOR DETERMINATION OF IMPURITIES IN PURE COPPER. Lihl, F.; (Technische Hochschule, Vienna); Patek, P.; Sorantin, H. *Z. Anal. Chem.*, 221: 176-86(1966). (In German).

The application of neutron activation analysis to the determination of impurities in pure copper is reported. After a theoretical introduction about the activation of the expected elements and possible errors, the preparation of samples, irradiation techniques, and γ -spectrometric measurements are described. The elements antimony, selenium, iron, silver, cobalt, zinc, nickel, and gold could be determined nondestructively. The quantitative determination was only possible after working out a chemical separation scheme, because of the activity of the matrix element and because of the overlapping of γ -energies. For comparison other analytical methods, x-ray fluorescence analysis and emission spectroscopy, were used, including the determination of lead and tin. The results of all analytical methods mentioned were in good agreement. The neutron activation method proved to be of high sensitivity and accuracy, but low rapidity in comparison to x-ray and emission spectroscopy. (auth)

1262 ACTIVATION ANALYSIS FOR TITANIUM AND NIOBIUM WITH FAST NEUTRONS. Athavale, V. T.; Desai, H. B.; Gangadharan, S.; Pendharkar, M. S.; Das, M. Sankar (Atomic Energy Establishment, Trombay, India). *Analyst*, 91: 638-46 (Oct, 1966).

Fast-neutron activation methods were developed for determining titanium and niobium. Scandium-47 formed by the (n,p) reaction on titanium-47 and yttrium-90 formed by the (n, α) reaction on niobium-93 were used for determining these elements. Irradiations were carried out in the swimming-pool reactor "Aspara" at the Atomic Energy Establishment Trombay, at a fission flux of 3×10^{11} n per cm² per sec. Radiochemical procedures were developed for the isolation of scandium and yttrium from the irradiated samples. The methods were applied to the determination of titanium in stabilized steels, and the standard rocks G-1 and W-1 and of niobium in stabilized steels. Advantages and limitations of the methods are discussed. (auth)

1264 NEUTRON ACTIVATION ANALYSIS OF IMPURITIES. COBALT AND NICKEL IN URANIUM COMPOUNDS OF NUCLEAR PURITY. Oerdoegh, M.; Csajka, M. (Zentralforschungsinstitut fuer Physik, Budapest). *Mikrochim. Acta*, No. 4-5, 606-11 (1966). (In German).

A method was developed for determining nickel and cobalt in uranium compounds of nuclear purity. The bulk of the uranium is removed by paper chromatography prior to the irradiation. Cobalt and nickel are determined with the aid of the isotopes ⁶⁰Co and ⁵⁸Ni respectively. Gamma spectrometry or the complement subtraction procedure was used to separate the two cobalt isotopes. (auth)

19572 NONDESTRUCTIVE DETERMINATION OF IMPURITIES IN RED PHOSPHORUS BY NEUTRON ACTIVATION AND GAMMA SPECTROMETRY. PART I. Patek, P.; Sorantin, H. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). *Z. Anal. Chem.*, 226: 338-46 (Feb. 22, 1967). (In German).

In six samples of red phosphorus of different origin trace elements were determined by nondestructive neutron activation analysis. Only those nuclides which have a half life shorter than 15 hours were analyzed. Qualitatively 8 elements were detected; some of them were analyzed quantitatively, comparing their activity with simultaneously irradiated standards. Larger differences in the amount of trace elements in the different phosphorus samples could be observed. Sodium and aluminium were the most important contributors to the impurity level. (auth)

10261 NUCLEAR METHODS FOR DETERMINING BORON IN SILICON. Dragnev, T. N. (Inst. of Physics, Academy of Sciences, Bulgaria). *Compt. Rend. Acad. Bulg. Sci.*, 19: 711-14 (1966). (In Russian).

The concentration of boron in silicon may be determined by a method combining the ¹⁰B(n, α)⁷Li reaction with the sensitivity of n-p transitions in silicon toward charged particles. The number of α particles resulting from the reaction is proportional to the number of boron atoms. This method, which makes it possible to determine concentrations down to 10⁻⁶%, was further improved by including a low-noise preamplifier, a spectroscopic pulse amplifier and a threshold amplifier in the system, increasing the sensitivity by a further order of magnitude. However, the method may be used only with single crystals; during the recrystallization of silicon the boron may be redistributed. To overcome this problem, thin disc-shaped specimens were used, keeping the thickness the same as the mean free path of the 0 to 1.5-MeV α particles, and recording the particles emitted at the two surfaces by means of a dual pulsed ionization chamber. A sensitivity of 10⁻⁶% was obtained with polycrystalline specimens. (TTT)

10278 DETERMINATION OF COPPER, GALLIUM, AND ZINC IN STANDARD ROCKS BY NEUTRON ACTIVATION. Brunfelt, A. O. (Oslo Univ.); Johansen, O.; Steinnes, E. *Anal. Chim. Acta*, 37: 172-8 (Feb. 1967).

A neutron activation method for the simultaneous determination of copper, gallium, and zinc in rocks is described. The method is based on anion-exchange separation steps and measurement of γ activity. Chemical yields were determined by re-activation. Results for a series of igneous "standard rocks" are presented. The accuracy of the mean values is ca. 5% for concentrations exceeding 10 ppM. (auth)

19547 THE APPLICATION OF NEUTRON ACTIVATION FOR DETERMINATION OF ELEMENTS IN ALUMINUM, MAGNESIUM, BERYLLIUM, AND THEIR ALLOYS. Rakovic, Miloslav (Charles Univ., Prague). *Jad. Energ.*, 12: 458-60 (Dec. 1966). (In Czech).

A brief review is given on neutron activation analyses for determining impurities in Fe and its alloys and Al, Mg, and Be and their alloys. (R.V.J.)

10253 (SGAE-CH-31/1966) BESTIMMUNG VON VERUNREINIGUNGEN IN ROTEM PHOSPHOR DURCH NEUTRONENAKTIVIERUNG UND GAMMASPEKTROMETRIE. (Determination of Impurities in Red Phosphorus by Means of Neutron Activation and Gamma Spectroscopy). Patek, P.; Sorantin, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf, Institut fuer Chemie). 1966. 15p. (In German). Dep. mn.

In six samples of red phosphorus of different origin trace elements were determined by non-destructive neutron activation analysis. Only those nuclides were determined, which have a half-life shorter than 15 hr. Qualitatively 7 elements were detected, some of them were analysed quantitatively, comparing their activity with simultaneous irradiated standards. Large differences in the amount of trace elements in the different phosphorus samples were observed. Sodium and aluminium were the most important contributors to the impurity level. (auth)

10293 RADIOACTIVATION DETERMINATION OF BISMUTH IN MINERAL MATERIAL. Lobanov, E. M.; Yankovskii, A. V. (Inst. of Nuclear Physics, Tashkent). *Zh. Anal. Khim.*, 21: 1420-2 (1966). (In Russian).

A method was developed for the radioactivation determination of bismuth in mineral powdered samples without using radiochemical methods. Bismuth is determined by measuring the α radiation from polonium accumulating in the analyzed samples on their irradiation by thermal energy neutrons in a nuclear reactor as a result of activation of ²⁰⁹Bi nuclei followed by β decay of ²¹⁰Bi. The method is highly selective for bismuth and can be used for bismuth determination in samples of complex composition. (auth)

10279 NEUTRON ACTIVATION ANALYSIS OF HIGH PURITY SELENIUM. PART I. DETERMINATION OF BROMINE. Bal-laux, C.; Dams, R.; Hoste, J. (Ghent Univ.). *Anal. Chim. Acta*, 37: 164-71 (Feb. 1967).

Neutron activation analysis for 2 to 0.8 ppm bromine in selenium was performed by irradiating 1 g samples for 2 hr at a neutron flux of 4×10^{11} n/cm²/sec. The bromine was separated by a double precipitation technique as silver bromide to obtain adequate decontamination and the isotope ⁸²Br ($T_{1/2}$ = 35.87 hr) measured. Errors due to self-shielding in the standards and flux-depression in the selenium were calculated. Measurements on 2 different photopeaks were made to avoid errors from interfering isotopes. (auth)

17813 A FAST IDENTIFICATION OF TRACES OF SILICON BY ACTIVATION ANALYSIS WITH 14 MeV NEUTRONS. Eden, Y. (Soreq Nuclear Research Center, Yavne, Israel). *Nucl. Instrum. Methods*, 49: 352-4 (1967).

Activation analysis is used for the identification of traces of silicon in some vacuum pump oils. The detection of silicon is based on the nuclear reaction ²⁸Si(n,p)²⁸Al induced by 14 MeV neutrons from a neutron generator. The 1.78 MeV γ -ray emitted by the ²⁸Al is measured, and the decay of the radioactivity (half-life = 2.3 min) is followed. The sensitivity of detection was 6 μ g. (auth)

12298 DETERMINATION OF IMPURITIES IN HIGH-PURITY NIOBIUM AND TANTALUM BY RADIOACTIVATION ANALYSIS. Kawashima, Toshi (Electrical Communication Lab., Tokyo). pp 61-5 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Neutron activation analyses followed by gamma spectrometry were developed for the determination of trace impurities in high-purity niobium and tantalum samples. (auth)

15864 DETERMINATION OF NEODYMIUM BY ACTIVATION ANALYSIS FOR CONTROL OF THE PREPARATION OF ¹⁴⁷Pm. Travesi, A. (Junta de Energia Nuclear, Madrid). *An. Real Soc. Espan. Fis. Quim. (Madrid)*, Ser. B, 63: 67-77 (Jan. 1967). (In Spanish).

A simple, inexpensive, nondestructive neutron activation analysis method is described for the determination of up to 0.02 mg/ml neodymium. The method is appropriate for process control in the preparation of ¹⁴⁷Pm. ¹⁵¹Nd is produced by neutron irradiation, and its activity is selectively measured by gamma spectrometry with the decay of the ¹⁵¹Nd photoelectric peaks being followed with a multichannel analyzer. The optimum irradiation time to obtain the most favorable ¹⁵¹Nd/¹⁴⁹Nd activity relation was studied, and the most appropriate photoelectric peak to best maintain this relation was selected experimentally. Chlorine present in the samples was eliminated prior to the irradiation to eliminate its interference. The method for elimination of the chlorine interference was checked with ¹⁴⁷Nd as a tracer to determine that no losses of Nd occur in the elimination process. (B.L.M.)

10248 (CNAEM-39) DETERMINATION OF THALLIUM BY ACTIVATION ANALYSIS BASED ON THE REACTION $^{203}\text{Tl}(n, 2n)^{202}\text{Tl}$. Talat-Erben, M.; Okar, Sevim (Cekmece Nuclear Research Center, Istanbul (Turkey)). Sept. 1966. 14p. Dep. mn.

An activation analysis based on the reaction $^{203}\text{Tl}(n, 2n)^{202}\text{Tl}$ is discussed. The product isotope ^{202}Tl has a convenient half-life of 12 days and is a gamma emitter, thereby making the determination specific. Because of the rather high threshold (8 to 9-MeV) for this reaction, the sensitivity was only about 20 μg of thallium for samples irradiated for 30 hr in the close-vicinity of the reactor fuel in a total flux of 10^{13} n/cm²/sec. (auth)

10274 DETERMINATION OF RHENIUM IN MOLYBDENITE BY NEUTRON-ACTIVATION ANALYSIS. Terada, Kikuo; Yoshimura, Yukio; Osaki, Susumu; Kiba, Toshiyasu (Kanazawa Univ., Japan). *Talanta*, 14: 53-60(1967).

A neutron-activation method is described for the determination of rhenium in molybdenite. Radiochemical separation by a carrier technique was carried out very rapidly by means of successive liquid-liquid extraction processes. The recovery of rhenium, which was determined by a spectrophotometric method, was about 93%. About 10 samples could be analyzed within 6 hr in parallel runs. (auth)

10296 RADIOACTIVATION METHOD FOR DETERMINING IMPURITIES IN SPECIALLY PREPARED SILICA. Chiotan, C.; Zamfir, I.; Curcaneanu, D. (Inst. of Atomic Physics, Bucharest). *Stud. Cercet. Chim.*, 13: 745-6(1965). (In Rumanian).

The sample (1 g) was treated with H_2SO_4 (1:2) (2 ml) and HF (5 ml) in a platinum capsule, and after slight agitation the capsule was heated for 15 min on a water bath; more HF (5.5 ml) was added, and the mixture was evaporated, with continuous stirring, to a syrup with no further evolution of H_2SO_4 . The residue was dissolved in water (15 ml), the solution was filtered, and the filtrate was evaporated to dryness on a water bath. The residue was sealed in a silica vial, then irradiated for 50 hr in a neutron flux of $\approx 4 \times 10^{12}$ neutrons per sq cm per sec. The γ spectrum of the product, measured after 30 days, showed two peaks, at 0.57

and 1.638 MeV, respectively, corresponding to ^{122}Sb and ^{124}Sb . The irradiated product was dissolved in very dilute HCl, and the radioactive impurities were analyzed by ascending paper chromatography, with concentrated HCl - H_2O -ethyl ether-methanol (4:15:50:30) as developer; the chromatogram showed peaks at R_F 0.0 (corresponding to Sb^{3+}) and at R_F 0.8 (corresponding to Sb^{5+}). (Analytical Abstr.)

1278 TRACE ANALYSIS OF URANIUM IN ROCKS WITH THE HELP OF NEUTRON ACTIVATION. Turkowsky, C.; Staerk, H. (Technische Hochschule, Munich). *Z. Anal. Chem.*, 221: 205(1966) (In German).

Amounts of uranium as small as 0.01 to 0.1% can be determined in rocks by neutron activation methods. After irradiation of the sample with resonance neutrons, uranium is extracted, and the

^{238}U counted. About 0.05 μg uranium/100 mg stone can be determined. (M.C.G.)

2993 ACTIVATION TECHNIQUES IN THE MEASUREMENT OF THE ^{235}U CONTENT IN DEPLETED URANIUM. Rustichelli, F.; Maracci, G.; Bresesti, M. (CCR-EURATOM, Ispra, Italy). *Nucl. Instrum. Methods*, 42: 333-5(July 1966).

It is shown that the ^{235}U content in depleted uranium can be measured by activation methods to a sufficient accuracy for most practical applications. Two methods were used. In the first method pairs of 0.1-mm-thick natural uranium and 0.2-mm-thick depleted uranium foils were irradiated in the thermal column of the Ispra I Reactor. The total gamma activity of the fission products was measured after a few hours cooling. In the second method pairs of natural and depleted uranium samples were irradiated in the graphite reflector of the Ispra I Reactor. The uranium samples were wrapped in Al foils. The 1.60-MeV gamma photopeak of ^{140}La was evaluated and assumed to be proportional to the ^{235}U content. (M.C.G.)

17577 ACTIVATION ANALYSIS OF PHILIPPINE URANIUM ORES BY DELAYED NEUTRON COUNTING. Julliano, J. O.; Julliano, P. O. (Philippine Atomic Research Center, Diliman, Quezon City). *Philippines Nucl. J.*, 1: No. 1, 9-16(July 1966).

Samples from the uranium deposit in Larap, Camarines Norte were analyzed by neutron activation and delayed neutron counting. The counting set-up and procedure are described in detail. The results of the analysis are compared with previous results obtained by radiometric analysis. (auth)

Separation

10286 USE OF SUBSTOICHIOMETRIC PRECIPITATION REACTIONS IN RADIOCHEMICAL ANALYSIS. von Baekmann, Adolf (Kernforschungszentrum, Karlsruhe, Ger.). *Z. Anal. Chem.*, 223: 161-9(1966). (In German).

The principle of substoichiometric final precipitation in radiochemical analysis is discussed by means of the following examples: activation determination of traces of zirconium and hafnium in high-purity aluminum, and determination of fission cesium in mixtures of fission products. (auth)

12322 NEW DEVELOPMENTS IN THE SYSTEMATIC ANALYSIS OF HIGH PURITY METALS AND ESPECIALLY OF ALUMINUM, COPPER AND ZIRCONIUM. Albert, P.; Cuypers, M.; Lesbats, A.; Mignonsin, E. (Centre d'Etudes de Chimie Metallurgique, CNRS, Vitry, France). pp 310-15 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

The systematic analysis of copper was developed using separations by electrolysis under controlled potential. The determination of sulfur was performed by different methods, depending on the relative concentration of this element and the phosphorus content in the copper samples. A great number of analyses were performed by this method on samples, and the total impurity concentrations which were determined varied from 0.6 to 25 ppm. A method of systematic analysis of zirconium, based on the initial separations by ion exchange with an anion resin of the impurities in eight groups, was studied. The advantage of this method was that the sample can be dissolved in a hydrofluoric-nitric medium, avoiding the principal disadvantages of the use of hydrofluoric acid. The determination of sulfur and phosphorus are possible in the systematic analysis. The systematic analysis of aluminum was improved at different points. One of the results of the study of the analysis of copper was the development of a scheme of separations of the radioisotopes of the elements that sulfides precipitate in an acid medium. These separations are now used on a routine basis in the systematic analysis of aluminum, iron, and zirconium. (auth)

17725 RAPID RADIOCHEMICAL SEPARATION BY ISOTOPIC AND ION EXCHANGE ON PREFORMED PRECIPITATES. Eckhardt, Wolfram; Herrmann, Guenter; Schuessler, Hans-Dieter (Univ., Mainz). *Z. Anal. Chem.*, 226: 71-88(1967). (In German).

Short-lived nuclides can be isolated by rapid isotopic and ion exchange between their solutions and preformed precipitates by sucking the solution quickly through a thin layer of the precipitate. It is shown with silver halides, cesium, barium, and thallium compounds how the exchange depends on the preparation, amount, and solubility of the precipitate, and on the composition and contact time of the solution. In a few systems not only the surface layer but the whole precipitate or most of it is involved in the rapid exchange. As an application an automatic separation

procedure is described for bromine and iodine nuclides from fission products by exchange with silver chloride, which can be completed within 2 seconds after irradiation. (auth)

15863 DETERMINATION OF ARSENIC IN ANTIMONY-IRON MATRICES BY ACTIVATION ANALYSIS. Dams, R.; Hoste, J. (Ghent Univ.). *Acta Chim. Acad. Sci. Hung.*, 50: 111-18(1966).

A procedure for the quantitative determination is of arsenic in 60% antimony and 14% iron was developed. The antimony and iron matrix was separated by solvent extraction with isopropyl ether and the arsenic was separated from zinc by precipitation with thioacetamide. The decontamination factors were higher than 5×10^3 . The ^{76}As was measured in the presence of non-negligible ^{122}Sb activity. It was determined gamma spectrometrically (measurement at two different energy levels) and by integral gamma counting (two measurements at different times). With the addition method of analysis a straight line was obtained. The activation analyses were carried out in two ways. The arsenic activity induced in the sample was compared with the activity induced in an identical sample to which a known amount of arsenic was added. A second determination was performed by the usual procedure, namely comparison against a standard of spectrographically pure antimony and iron oxides with known arsenic concentrations. Concentrations ranging from 900 to 15 ppm were determined by a neutron irradiation of 2 hours at 5×10^{11} n/cm²/sec. The chemical procedure takes less than 2 hours. (auth)

2943 USE OF 8-HYDROXYQUINOLINE FOR THE SEPARATION OF ^{90}Y IN THE DETERMINATION OF ^{90}Sr IN BIOLOGICAL MATERIALS. Burton, J. D.; Love, R. M.; Mercer, E. R. (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). *Analyst*, 91: 739-41 (Nov. 1966).

Homogeneous precipitation of yttrium carrier as the 8-hydroxyquinolate was used for the isolation and purification of ^{90}Y after the separation of the parent ^{90}Sr from biological materials. The technique was compared with the generally used method of separating by hydroxide and oxalate precipitations and estimating the recovery by weighing as the oxide. The two methods are of similar accuracy. Satisfactory decontamination from radioactive strontium was obtained by a single precipitation. The 8-hydroxyquinolate can be weighed directly for measurement of chemical yield, and it has a more favorable gravimetric factor than yttrium oxide. (auth)

10276 SUBSTOICHIOMETRIC SEPARATION IN ACTIVATION ANALYSIS. EXTRACTION OF COORDINATIVELY UNSOLVATED SALTS. Allmarin, I. P.; Perezhogin, G. A. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). *Talanta*, 14: 109-19 (1967).

The necessary conditions were examined for use of extraction of coordinatively unsolvated salts for substoichiometric separations in activation analysis, especially with regard to the influence of interfering ions and of the concentration of the carrier. A study was made of the substoichiometric extraction of halide ions, oxyanions, and anionic metal complexes by means of the tetraphenylarsonium ion into chloroform and dichloroethane, and of the extraction of alkali metal ions into nitrobenzene with tetraphenylborate. Substoichiometric extraction can be combined with neutron-activation analysis for determination of traces of iodine, cesium, rubidium, manganese, rhenium, chromium, thallium, gold, gallium, and tantalum. (auth)

12302 PAPER-CHROMATOGRAPHIC SEPARATION METHOD FOR ACTIVATION ANALYSIS. Bock-Werthmann, W.; Schulze, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). pp 120-2 of Proceedings of 1965 International Conference on Modern Trends in Activation Analysis. College Station, Tex., Texas A and M Univ., 1965.

Investigations of a wide range of inorganic/organic liquid mixtures were made to select a procedure to separate a large number of elements into groups of good radiochemical purity. The number of elements in each group was usually so small that individual radioactivities could be separated easily by subsequent γ spectrometry or decay curve analysis. Results showed that the mixture 420 ml ethanol, 30 ml HCl, and 150 ml H_2O gave best results. Mixture did not store well and quite different conditions were found if percentages varied slightly. In some analyses individual radiochemically pure elements were obtained. When the induced radioactivities were of short half-life, the chromatographic separation had to be made prior to activation. Under these conditions the blank introduced by the filter paper resulted in a much less favorable sensitivity, even when chromatographic paper with the lowest available trace-element content was used. (P.C.S.)

4467 PRODUCTION OF RADIOACTIVE STANDARDS FOR PAPER CHROMATOGRAPHIC SEPARATION. PART 2. SEPARATION OF ^{90}Sr AND ^{90}Y WITH THE HELP OF RING OVENS. Sorantin, H. (Technische Hochschule, Vienna). *Mikrochim. Acta*, No. 6, 957-64 (1966). (In German).

The nuclide pair ^{90}Sr - ^{90}Y was separated into its components on various kinds of paper in the ring furnace through various chemical separatory operations. The fastest separation occurred with 0.1 to 0.2N ammonium thiocyanate solution, the ^{90}Y being retained in the central portion of the paper disk while the ^{90}Sr was concentrated in the outer ring. A reversal was accomplished by sulfate precipitation or extraction with theophyllinefluoroacetone (TTA). In these cases the divalent ion remained in the center while the trivalent ion was washed into the ring. The separatory effect was detected autoradiographically through the decrease of the isolated ^{90}Y . The respective activity zones of the separated radio nuclide could be punched out and used as a relative standard. (auth)

15982 RADIOCHEMICAL SEPARATION OF LEAD BY AMALGAM EXCHANGE. Qureshi, Iqbal H.; Nagi, Fazal I. (Atomic Energy Centre, Lahore). *Talanta*, 14: 323-7 (Mar. 1967).

An amalgam exchange technique was used for the rapid radiochemical separation of lead. A number of variables that affect the exchange were studied and a lead yield of 88.5% was obtained. At room temperature the procedure required about 13 min, whereas at 40°C it was completed in about 9 min. Radioactive tracers of 16 different elements were used to check the selectivity of this procedure, which was applied for the separation of ^{212}Pb from thorium nitrate solution. (auth)

15853 DETERMINATION OF BORON BY THERMAL NEUTRON CAPTURE GAMMA-RAY ANALYSIS. Garbrah, B. W.; Whitley, J. E. (Scottish Research Reactor Center, Glasgow). *Anal. Chem.*, 39: 345-9 (Mar. 1967).

Thermal neutron capture γ -ray analysis was applied to the determination of boron in steel using a 2- by 2-inch NaI(Tl) crystal. Analysis is based on the well known 477-keV γ ray which is emitted in 93% of all thermal neutron captures in boron. Correction factors provided for thermal neutron flux depression in boron also make the technique applicable to the determination of large boron samples. (auth)

15981 RADIOCHEMICAL SEPARATION BY MEANS OF THE RING-OVEN METHOD. I. THE SYSTEM ^{137}Cs - ^{137m}Ba . Klockow, D. (Univ., Freiburg i. B.). *Talanta*, 14: 317-21 (Mar. 1967). (In German).

The application of the ring-oven method to radiochemical separations is exemplified by separation of the mother-daughter pair ^{137}Cs / ^{137m}Ba . The ^{137m}Ba was separated from ^{137}Cs in about 2 min on a filter circle impregnated with an insoluble ferrocyanide or heteropoly acid salt, and after re-establishment of radioactive equilibrium was "milked off" again. The yield of ^{137m}Ba obtained was 80 to 100% for the ferrocyanide-impregnated paper and 50 to 70% for a paper impregnated with a phosphomolybdate or tungstomolybdate. The decontamination factor ranged from 10^3 to 10^5 . The half-life of the separated ^{137m}Ba was calculated to be 2.570 ± 0.006 min. (auth)

2964 DETERMINATION OF ^{210}Pb BY DITHIZONE EXTRACTION AS ^{210}Bi . Ashizawa, Takashi; Nagasawa, Kikuo; Haruyama, Kanji (Japan Atomic Fuel Co-op., Tokyo). *Bunseki Kagaku*, 13: 1011-16 (1964). (In Japanese).

Optimum conditions were established for the extraction of Bi into dithizone in CCl_4 , and a method was devised for determining ^{210}Pb in uranium ore. The sample, plus carrier Pb, is dissolved in aqua regia, then Pb is precipitated as sulfate. The precipitate is converted into carbonate, and this is dissolved in HNO_3 . The solution is made 0.1M in acetate and its pH is adjusted to 1.5 with NH_3 ; it is then shaken with dithizone in CCl_4 (2×10 ml), and the aqueous layer is set aside for 3 days for the growth of ^{210}Bi , which is similarly extracted and determined by β counting. (Analytical Abstr.)

4609 A DEVICE FOR THE LOW AND HIGH TENSION PAPER ELECTROPHORESIS. A METHOD OF RAPID SEPARATION OF RADIOACTIVE COMPOUNDS. Kapuscinski, Andrzej (Zakladu Radioizotopow Katedry Radiologii AM, Warsaw). *Pol. Przegl. Radiol. Med. Nuklearnej*, 30: 557-9 (Sept.-Oct. 1966). (In Polish).

An apparatus for high and low voltage paper electrophoresis was designed and constructed. It was used for the separation of large and small molecular compounds on paper bands and on other media (e.g. the agar gel, the starch gel). (J.G.B.)

17573 USE OF ION-EXCHANGE CHROMATOGRAPHY IN ACTIVATION-ANALYSIS DETERMINATION OF SODIUM AND POTASSIUM IN MOLYBDENUM AND TUNGSTEN. Doege, H.-G. (Institut fuer Metallphysik und Reinstmetalle, Dresden). *Anal. Chim. Acta*, 38: 207-11 (May-June 1967). (In German).

A method for the determination of traces of sodium and potassium in molybdenum or tungsten by activation analysis is described. Radiochemically pure ^{24}Na and ^{42}K were separated from other radionuclides by anion- and cation-exchange chromatography. The limits of detection are 5 ppB of sodium and 50 ppB of potassium. (auth)

8404 RADIOCHEMICAL ANALYSIS USING ION EXCHANGE RESINS IN MIXED AND ANHYDROUS SOLVENTS. I. SEPARATION OF ^{137}Cs FROM MIXTURES AND SEPARATION OF THE RADIOACTIVE ISOTOPES ^{137}Cs - ^{89}Sr - ^{144}Ce AND ^{140}Ba - ^{140}La IN ANIONITE AV-17 IN AQUEOUS ORGANIC NITRIC ACID SOLUTIONS. Zaborenko, K. B.; Bogatyrev, I. O.; Malygina, N. L. *Radiokhimiya*, 8: 352-7 (1966). (In Russian).

The sorption of the radioactive isotopes ^{137}Cs , ^{89}Sr , ^{144}Ce , and ^{140}Ce on the weakly basic anionite AV-17 from aqueous organic solutions containing nitric acid was investigated. The dependence of the distribution coefficients on the concentration and nature of the organic solvent and concentration of the nitric acid was studied. A method for the ion exchange separation of the radioactive isotope mixtures Cs-Sr-Ce and Ba-La in aqueous organic nitric acid solution is proposed. Cs was separated from mixtures with passage through an anionite column of a 95% solution of acetone (0.5 N in HNO_3), Sr or Ba was eluted then with 85% CH_3OH (0.5 N HNO_3), and Ce or La was eluted with aqueous solutions of nitric acid. (tr-auth)

Isotope Dilution

2962 MICRO-DETERMINATION OF IODIDE BY ISOTOPIC-DILUTION ANALYSIS. Beronius, P. (Royal Inst. of Tech., Stockholm). *J. Electroanal. Chem.*, 9: 473(1965).

A solution containing w_1 μg of I^- labeled with ^{131}I is placed in an electrolytic cell, and its specific activity is determined by depositing $\approx 1\%$ of its iodine content on a silver anode and then measuring the activity of the deposit. The test solution (containing w_2 μg of I^-) is then placed in the cell, and the change in activity is established by a second deposition on a fresh anode. The value of w_2 is then calculated from $w_2 = w_1(A_1/A_2 - 1)$, where A_1 and A_2 are the activities per unit amount of electricity passed for the first and second anode, respectively. The technique was used for determining ≈ 20 μg of I^- . (Analytical Abstr.)

1297 DETERMINATION OF NITROGEN IN TITANIUM BY AN ISOTOPE-DILUTION METHOD. Orlova, K. B.; Vitol, E. N. *Zh. Anal. Khim.*, 21: 1263-6(1966). (In Russian).

An isotope dilution method was used for the determination of nitrogen in titanium. Results obtained are in good agreement with data of the chemical method. Sensitivity of the isotope dilution method is one order higher than that of the chemical method. It is $5.10^{-4}\%$ (weight) for a 1 g sample. (auth)

12347 METHOD OF ISOTOPE DILUTION. Broda, E. (Univ., Vienna). *Chimia (Aarau)*, 21: 8-15(Jan. 16, 1967). (In German).

The principle and history of the isotope dilution method are discussed. The use of "inverse isotope dilution method" in trace analysis is described. A combination of isotope dilution and radio-reagent method is used when the substance to be determined is labeled at a later stage by a reaction with radioisotopes. (D.H.M.)

17 ANALYTICAL METHOD BASED ON ISOTOPIC DILUTION OF A RADIOACTIVE MATERIAL. II. Klas, Jan (Slovak Polytechnic Inst., Bratislava). *Chem. Zvesti*, 20: 530-7(1966). (In Czech).

Analytical evaluation of the Block-Anker and Limakov-Rozavskij double isotopic dilution method indicated a higher accuracy of the single isotopic dilution method. Equations describing relative incongruencies in the analysis are given and some simplifications and corrections are suggested. (R.V.J.)

15829 (AERE-R-5310) THE APPLICATION OF ISOTOPE DILUTION MASS SPECTROMETRY TO BURN-UP DETERMINATION. PART I. URANIUM. Foster, E.; Fudge, A. J.; Steele, C. L. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1967. 37p. Dep. mn. CFSTI \$3.00 cy, \$0.65 mn. HMSO 5s, 6d.

Isotopic dilution, coupled with mass spectrometric analysis, has a number of important advantages over other techniques when applied to uranium for determination of burnup. Both the experimental and the theoretical aspects of this technique are considered for the analysis of samples of irradiated potential nuclear fuels, and results by this method compared with those obtained by other methods. Limitations of the isotopic dilution method due to inaccuracies in the nuclear data and to contamination from uranium are discussed. A computer programme, which enables the mass of uranium in the sample and the burnup to be calculated from the isotopic ratios resulting from mass spectrometric measurements, is included. (auth)

5773 A CONTRIBUTION TO ANALYSIS BASED ON ISOTOPIC DILUTION OF A RADIOACTIVE MATERIAL. II. Klas, Jan (Katedra Anorganické Chemie, Bratislava). *Chem. Zvesti*, 20: 530-7(1966). (In Czech).

The accuracy of the double isotopic dilution method of Bloch and Anker and of Zimakov and Rozhavskij was investigated. An equation developed for the relative deviation of the analysis combines the relative deviations of the added quantities of material and the relative deviation of the determinations of specific activity. The equation is adaptable to simple methods of isotopic dilution. It is shown that the maximum accuracy for the double dilution method is achieved at the same set of conditions as for simple dilution. The general accuracies of both methods are compared, and the relative accuracy of the double method is found to be less than that of the single method by a factor of at least $(1 + \text{dilution factor for second step})$. The equations are set up in forms for practical application for constant number of decompositions and for constant time. The relative deviation is minimal when $(i_1/i_2) - 4$ ($i = 1 + \text{dilution factor}$), so that if i_2 is constant, this may serve as an optimization for analytical conditions. (BBB)

8208 ANALYSIS BASED ON ISOTOPIC DILUTION OF RADIOACTIVE MATTER. Klas, J. (Inst. of Chemical Tech., Bratislava). *Chem. Zvesti*, 18: 250-8(1964). (In Czech).

The accuracy and optimum conditions of analysis by direct and reverse isotopic dilution were studied by the use of an equation expressing the relative deviation of the analysis. (Analytical Abstr.)

Radiation Absorptiometry

3219 NON-DESTRUCTIVE DETERMINATION OF HYDROGEN IN ORGANIC SOLVENTS BY NEUTRON SLOW-DOWN PROCESS. Ishii, Daido; Hirose, Yoji; Mori, Hideo; Kato, Koichi (Nagoya Univ., Japan). *Bunseki Kagaku*, 15: 1320-7(Dec. 1966). (In Japanese).

A rapid nondestructive method based on the slowing-down process of neutrons by hydrogen nucleus was investigated for determination of hydrogen content in organic solvent. Fast neutrons from an Am-Be neutron source were moderated by the sample to thermal neutrons, which were then measured by a BF_3 -counter. The logarithm of the counting rate was found to be directly proportional to the content of hydrogen in the range 60 to 120 mg/ml using 50 ml sample. The immersion-arrangement was suitable for this determination and some graphite-blocks were used effectively as the thermal neutron reflector. The influence of coexisting carbon and oxygen content on the calibration curve was not perceptible. The application of the method into the range of lower hydrogen content, such as 0 to 100 mg/ml, was also examined. (auth)

12700 BUOYANCY TYPE APPARATUS FOR DETERMINING HYDROGEN CONTENT IN FLUIDS WITH GAMMA RAYS. Amrehn, Hermann (to Chemische Werke Huels, AG). U. S. Patent 3,280,327. Oct. 18, 1966. Priority date July 14, 1961, Germany.

A buoyancy type apparatus is described for continuously indicating the ratio of hydrogen atoms to other atoms in flowing fluids or liquids (H/R) using high-energy gamma rays. The apparatus consists of a hollow container, preferably a vertically disposed tube that is closed on top and bottom. The top serves as a detector window, and a gamma radiation detector is disposed on the top of the tube at this window. A liquid outlet is located close to the top of the tube near the window, and the liquid inlet is located near but not at the bottom of the tube so that a calm zone is defined between the bottom of the tube and the liquid inlet. A regularly shaped member containing a gamma source near the center or at least on a vertical line taken through the center of gravity of this floating member floats freely in the calm zone. A buoyancy adjustment chain is suspended from the bottom of the floating member, and the chain is partially suspended freely and partially lying on the bottom of the vessel during operation. With changing density of fluids, the distance between the source and detector changes to give an indication of the density of the fluid, and thus a ratio of atoms. (B.L.M.)

19571 RAPID ASSAY OF HIGH PURITY GOLD BY MEANS OF RADIOISOTOPE X-RAY FLUORIMETRY. Snyman, G. C. (Atomic Energy Board, Pelindaba, South Africa). *Int. J. Appl. Radiat. Isotop.*, 18: 243-6(Apr. 1967).

The use of ^{241}Am to analyse high-purity gold by excitation of characteristic silver x rays is described. The complete assay is effected in 5 min, and is accurate to 2 parts in 10,000 for 99.50% gold. (auth)

4453 DETERMINATION OF SULFUR CONTENT IN FUEL OIL BASED ON CONSTANT VOLUME METHOD BY X-RAY ABSORPTION OF TRITIUM BREMSSTRAHLUNG. Noguchi, Nobuhiko; Nomura, Masataka (Tokyo Electric Power Co., Inc.). *Radioisotopes (Tokyo)*, 15: 301-9(1966). (In Japanese).

An x-ray absorption method by bremsstrahlung from a tritium-zirconium source (2.5 Ci) was studied as a rapid method for the estimation of sulfur content in fuel oil. The intensity of transmitted radiation was measured by means of a Geiger Müller counter and scaler. A constant volume method was adopted for calibration and a polypropylene film punch (50 μ in thickness) was used for a sample vessel. The sulfur content of the sample was calculated upon the correction procedures of density, temperature, and carbon-hydrogen mass ratio, and counting rates, by the x-ray counting rate of standard aluminum plate as well as by the β counting rate of a standard pure hydrocarbon, n-heptane. The carbon-hydrogen mass ratio of the sample was determined on the basis of a strontium-90 β radiation source (96 μCi) by the same basic apparatus. The results showed that the method is applicable for fuel oil containing up to 5% sulfur. The time required was around 10 to 15 minutes, including calculation. Accuracy was approximately 1.3 to 1.7% depending on sulfur content. (P.C.H.)

5779 ANALYSIS OF METALLURGICAL RAW MATERIALS BY β -RAY BACKSCATTERING. Jirkovsky, R. (Inst. of Mining, Ostrava, Czech.). *Hutn. Listy*, 20: 506-9(1965). (In Czech.). Application of the technique to the analysis of ferrosilicon, chromium ores, and chromium and tungsten slags is reviewed. (20 references.) (Analytical Abstr.)

14168 ANALYTICAL METHODS BASED ON REFLECTION AND ABSORPTION OF RADIOACTIVE RADIATION. IV. EVALUATION OF PROCESS CONTROL APPLICATION OF THE RADIOMETRIC METHOD IN TECHNICAL CONTROL OF CONTRAST MATERIALS. Schiller, P.; Synek, J. (Komenskeho Univ., Bratislava). *Cesk. Farm.*, 15: 508-9 (Nov. 1966). (In Czech).

A nondestructive radiometric method is described for determination of iodine concentrations below a specified minimum or above a set maximum. The method employs reflection of radioactive rays. The analysis is completed in 10 min as compared to a chemical analysis employing wet decomposition of the substance and argentometric determination using potentiometric indication, which requires $1\frac{1}{2}$ to 3 hr. (TSS)

25 RADIOMETRIC DETERMINATION OF SULFUR IN LIQUIDS AND GASES. DETERMINATION OF SULFUR IN LIQUID. Lyast, I. Ts.; Vshivtsev, A. D. *Khim. Seraorgan. Soedin., Soderzhashch. v Neft. i Nefteprod., Akad. Nauk SSSR, Bashkirsk. Filial*, 7: 227-32 (1964). (In Russian).

Sulfur is determined radiometrically from the absorption of soft γ -radiation of an ^{66}Fe or tritium source. One beam is sent through a container with the sulfur compound, and another beam is sent through a compensating wedge. The difference current is amplified and modified to give direct readings of the sulfur content on a microammeter. The angle of rotation of the wedge is proportional to the absorption ability of the sulfur compound. The ionization chamber is filled with argon gas to obtain a maximum ionization current, which increases by a factor of 2.2, 3.5, and 8 for chamber volumes of 5.0, 1.4, and 0.35 l respectively, when compared to counting in air. The chamber is 8 cm in dia and 10 cm high. Sulfur contents can be measured in the range of 0.1 to 2.0% with a measurement error of $\pm 0.01\%$ in benzene, kerosene, or diesel oil fuel. The analysis requires 3 to 4 min. The source activity is 1 to 5 mCi. A ^{90}Sr source is also included in the unit along with an ^{56}Fe source in order to determine the composition of carbon and hydrogen in hydrocarbon products. The mass absorption coefficient by a photoelectric mechanism increases with the fourth power of the atomic number of the absorber. (TTT)

2958 ON IMPROVED SENSITIVITY OF β REFLECTION ANALYSIS. Boyarshinov, L. M.; Senyavin, M. M. (*Moscow Inst. of Steel and Alloys*). *Zavodsk. Lab.*, 32: 1220-3 (1966). (In Russian).

A β - β reflection method with the reflected electron intensity as a function of atomic number close to Z^2 was used in order to improve the sensitivity of the analysis. The scheme of a device with annular aperture and six parallel connected Geiger counters around the ring is described. (R.V.J.)

2996 RAPID X-RAY SPECTROCHEMICAL ANALYSIS OF CEMENT MATERIAL, USING A RI-SOURCE AND 400-CHANNEL PULSE-HEIGHT ANALYZER. Imamura, Hiroshi (Ube Kosan Co., Ltd., Japan); Tominaga, Hiroshi. *FAPIG (Tokyo)*, No. 38, 191-5 (Oct. 1965). (In Japanese).

Using a RI-source emitting α rays and soft X rays, main components (Fe, Ca, Si, Al, and Mg) of cement material were determined by an energy spectrophotometer, consisting of a proportional counter and multichannel pulse-height analyzer, without using an analyzing crystal. The measuring head employed was ^{210}Po α and $^3\text{H}/\text{Zr}$ x ray sources. The intensity of generated fluorescent x rays was measured by two gas-flow counters, and the pulse-height spectrum by a 400-channel PHA (pulse height analyzer). To avoid absorption loss, the source head was kept in a vacuum, and the α window was covered with a 1.5 mg/cm² Al foil. The 400-channel PHA, divided into two 200-channel units by anticoincidence routing, measured the spectra simultaneously, and were connected to an electronic computer, which recorded the experimental results. The sample was prepared by fusing with $\text{Li}_2\text{B}_4\text{O}_7$ and making it into a glassy disc. When the counter had an Al-filter, only the pulse height distribution of SiK x rays disappeared. Without an Al filter the pulse-height distributions of Si and AlK x rays overlapped. Ca and FeK x rays did not overlap with a Si-Al-Mg overlapped peak. Considering these points, the channel levels for the respective elements must be carefully selected for the channel integration. To

stabilize the spectra, a specially designed stabilizer circuit was used. Correction for the matrix effect is possible, using the equation $N_i = a_{i0} + \sum_j a_{ij}x_j$, by applying constants to this equation with a repeated experimental value. The standard deviations for Fe_2O_3 , CaO , SiO_2 , and Al_2O_3 are 0.005, 0.30, 0.19, and 0.09 wt %, respectively. (NSA of Japan)

Gages

19858 LOGARITHMIC INTEGRATOR FOR RADIOISOTOPE GAUGES. Lopuszniak, Andrzej (Instytut Elektrotechniki, Warsaw). *Nukleonika*, 12: 157-66 (1967). (In Polish).

Calculations are presented of approximation of the integrator characteristic, to the logarithmic characteristic, which is done by adding two diode pump characteristics. The application of this integrator to the linearization of the radioisotope gage characteristics in which the relation between the intensity of radiation and the measured value is given by an exponential equation is described. An error in linearity of radioisotope gage with this integrator depends on the range of radiation intensity change and is contained between about $\pm 0.1\%$ to $\pm 0.86\%$. The mode of designing the integrator and a graph of an error in linearity of the radioisotope gage containing this integrator are discussed. (tr-auth)

19859 SIMPLIFIED METHOD OF ANALYTICAL DETERMINING OF THE BUILD-UP FACTOR FOR GAMMA RADIATION. Czarnecki, Jerzy; Kowalik, Stanislaw (Katedra Obrony Przeciwdziałomowej, Warsaw). *Nukleonika*, 12: 143-56 (1967). (In Polish).

An effective method for determining the buildup factor for the most commonly found measuring geometries in the use of isotopes for industrial purposes is described. An experimental attempt to determine them is discussed. The discussion is limited to the radiation source typical for the apparatus, i.e., ^{60}Co , to the typical materials of construction for the walls of the iron reservoir used as a radiation absorbent, and to the G-M counter as a detector (the measurements were performed for the counters STS-6 and STS-5). Using the absorption curves obtained by the measurements, a series of generalized formulae was derived defining the absorption coefficient as a function of such parameters as the collimation coefficient of the beam of gamma radiation, distance from the source and distance of the detector from the absorbing layer. (tr-auth)

10689 MEASUREMENT EQUIPMENT FOR TECHNICAL USE OF RADIONUCLIDES. Kosmowski, Alfred (Frieeseke and Heepner GmbH, Erlangen-Bruck, Ger.). *Z. Instrum.*, 74: 291-4 (Sept. 1966). (In German).

The suitability of sealed radiation sources containing certain radionuclides such as ^{147}Pm , ^{85}Kr , ^{204}Tl , ^{90}Sr , ^{90}Y , ^{106}Ru , ^{106}Rh , ^{137}Cs , and ^{60}Co for measurement of thickness, and Ra-Be or Am-Be sources for measurement of mixture content are reviewed. Recent uses of currently developed transistorized equipment, equipment configuration for single or double sided measurements, principles of thickness measurement with radioisotopes, examples of equipment, and measurements of suspensions are discussed. Humidity and moisture content measurements with neutron sources are illustrated by examples found in bulk goods manufacturing and in soil moisture studies. Examples of equipment used and their sensitivity characteristics are discussed briefly. Measurements of moisture content may require from 15 to 180 sec and give results with an accuracy range between 0.1 to 0.3% moisture. Soil moisture content can be measured with an accuracy of $\sim 1\%$. (BBB)

12697 (STI-PUB-21/20) RADIOISOTOPE INSTRUMENTS IN INDUSTRY AND GEOPHYSICS. Bibliographical Series No. 20. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1966. 428p. IAEA: \$8.50; Austrian Schillings 220,-; £3.9.0.; F Fr 41.70; Dm 34,-.

A bibliography, No. 20 in the Bibliographical Series, concerned with the design and applications of radioisotope instruments is presented. References and abstracts were obtained from Nuclear Science Abstracts and from Radioisotopes in World Industry. References are classified by technique and field of application. Industries are classified according to the International Standard Industrial Classification of All Economic Activities. (R.C.K.)

- 4721** PERFORMANCE OF INSTRUMENTATION FOR NUCLEAR TECHNIQUES IN MEASUREMENT, CONTROL, AND AUTOMATION MADE BY THE DRESDEN VACUTRON VIB PLANT. Khaimann, R. 21p. (In Russian). (CONF-641024-1). DTIC.

From Symposium on Use of Radioisotopes, Warsaw.

Stationary and movable thickness gages, which are widely used in plastics fabricating plants and in aluminum- and paper-rolling mills, contain ^{85}Kr , ^{204}Tl , or ^{90}Sr sources. An automatic thickness gage has operated for 3 years in a cable factory on resins of 0.3 to 1.2 mm thickness with a precision of ± 0.02 mm. A cord-rolling operation is monitored with a beta back-scattering gage. A densitometer using 320 μCi of ^{137}Cs determines the solids content of a suspension of fat by measuring the gamma absorption. Another gage is made which can regulate the density of the tobacco in cigarettes. Gamma-source equipment is made for controlling the electric conveyors in mines and for making the red signals at danger spots, and coke carriers, for example, have been successfully lined up with such equipment for 4 years. A gamma gage has been used for close control of the level in a heated vessel whose contents are mixed by a stirrer operating at 20 rpm and for regulating the feed. Productivity was increased when a gamma gage was used to change the slope of a conveyor-belt system several kilometers long. A ^{60}Co gage is made for measurements inside a thick-walled concrete structure, e.g., a generator enclosure. A source mounted inside a tube serves as a probe for measuring levels inside pressurized vessels in large electric-power stations. (TTT)

- 4717** (AEC-tr-6699) CATALOG OF THE INSTRUMENTS USING NUCLEAR SOURCES AND UTILIZED FOR CONTROLLING AND AUTOMATION OF TECHNICAL PROCESSES, PRODUCED BY THE ALL-UNION GROUP "ISOTOPE," 1965. Translation of Katalog Priboiy, Deistvie Kotorykh Osnovano na Ispol'zovanii Istochnikov Yadernykh Izlucheni, dlya Kontrolya i Avtomatizatsii Tekhnologicheskikh Protessov, Postavlyayemye Vsesoyuznym Obbedineniem "Izotop" v 1965, Atomizdat, Moscow, 1965. 59p. Dep. mn. CFSTI \$3.00 cy, \$0.65 mn.

The design and performance of 58 radioisotope devices for the control and automation of technical processes are given. These instruments include relay-type devices, level, thickness, and density gages, industrial defectoscopic devices, and others. Radioisotope devices in the developmental stage are also discussed. (J.F.P.)

- 14389** (EUR-2776.d) DIE ANWENDUNG GESCHLOSSENER RADIOISOTOPE IN DER INDUSTRIE (FALLSTUDIEN 5 bis 8).

(The Use of Sealed Radioisotopes in Industry (Key Studies 5 to 8). Wiczorek, H.; Erhardt, H. (Laboratorium Prof. Dr. Berthold, Wildbad im Schwarzwald (West Germany)). 1966. 30p. (In German). Dep. mn.

Studies were made to examine typical instances of the use of sealed radioactive isotopes in industrial measuring methods. All technical, economic and labor-research aspects involved in the use of isotopes are discussed. The measurement of the charge height in a cupola furnace and the application of nuclear level gauging devices in automatic charging are described. The use of the isotope-regulated charging hoist has the effect of increasing a cupola furnace's productivity in terms of man-power and making the smelting operation a smoother process. By saving labor, the costs of the isotope hoist is recovered in about 3 months' time. Studies were also conducted on the use of isotopes to measure the filling height in pressure tanks in which chemical syntheses are carried out. In the case investigated, the nuclear method was the only possible way of measuring the level in the pressure vessel and thus, in addition to the level gaging, made it possible to distinguish the various phases of the medium and the occurrence of foam. The use of radioactive isotopes in measuring filling level and density in the production of aluminum oxide from bauxite according to the Bayer process was investigated. Owing to the heavy incrustations that occur in the tanks, the conventional instruments cannot be employed. In this process the continuity of the whole system depends essentially on the use of such nuclear equipment. Its introduction offers the best solution of level gaging and density measurement as well as the control problems present in this process. (tr-auth)

- 17777** (RT-ING-(66)11) MISURA DELLA FRAZIONE VOLUMETRICA DI VAPORE COL METODO DELL'ATTENUAZIONE γ . Rapporto di Avanzamento al 30 Giugno 1965. (Volumetric Fraction Measurement of Vapor by the γ Attenuation Method. Progress Report for June 30, 1965). Lupoli, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 59p. (In Italian). Dep. mn.

Problems related to void fraction measurement by the γ -ray attenuation method are examined. The measuring circuit and measurement technique are described and a detailed analysis is made of the most important parameters which define the calibration curve and the errors. (tr-auth)

- 17778** (RT-ING-(66)12) MISURA DELLA FRAZIONE VOLUMETRICA DI VAPORE COL METODO DELL'ATTENUAZIONE γ . Rapporto di Avanzamento al 30 Settembre 1965. (Volumetric Fraction Measurement of Vapor by the γ Attenuation Method. Progress Report for September 30, 1965). Lupoli, P.; Festoso, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 59p. (In Italian). Dep. mn.

Results are presented of void fraction measurements by the γ -ray attenuation method in plexiglass models of rectangular and tubular channels. The best conditions of measurement are investigated and the analysis of errors is made for each test section. (tr-auth)

- 18108** BETA BACKSCATTER OF DENTAL MATERIALS. Andreas, M. Deut. Stomatol., 15: 198-202 (Mar. 1965). (In German).

Backscatter of β particles has been used as a method of measurement in dental industry for many years. The author briefly sketches the general procedures used for measurements of back scattering produced by various dental alloys of different compositions. These measurements were used to analyze the porosity of various plasters and plastics and to determine the thickness of metallic foils used in dentistry. The hardening process of various dental amalgams was studied with these procedures. Volume changes that are known to take place in amalgams that contain different amounts of Ag were ascertained with the backscatter method described. The hardening of dental amalgams containing 50% Ag was studied. The effects of temperature on hardening were similar at various temperatures but varied quantitatively. Since volume changes are indicated by reciprocal changes in density, it was found that they could be determined by β scattering procedures. This method was found to be applicable for studies of deformation, liquation, and recrystallization phenomena. (BBB)

Ionization

- 17905** CONSIDERATION ON THE USE OF RADIOELEMENTS IN THE MEASUREMENT OF GAS FLOW. Courtois, G.; Toudoire, B. (CEA, Saclay, France). Bull. Inform. Appl. Ind. Radioelem., No. 63, 6-12 (Jan.-Feb. 1967). (In French).

The possibilities of using two radioactive methods for the measurement of gas flow are discussed. The discontinuous methods using radioactive tracers are examined. These include dilution methods, time integration, and two peak methods. The continuous methods using the ionization of the radiation of sealed sources are

also examined. The advantages and disadvantages of each type of method are given. (tr-auth)

- 17904** DEVELOPMENT OF RI-METHANOMETER. 2. Matsuguma, Kiso; Oba, Shigeyoshi (Resources Research Inst., Kawaguchi, Japan). Saiko To Hoan, 12: 462-8 (Sept. 1966). (In Japanese).

Based on the results of basic experiments two RI-methanometers were designed and manufactured. One of these is for 0-100 percent methane and the other for 0-10 percent methane, both having almost the same structures and electric circuits. This methanometer, contained in an explosion proof case, consists mainly of two ionization chambers, dc amplifier, power supply and alarm circuit. Its output, which is indicated on a 100 micro-ammeter scaled in methane percent, can also be connected to a self-balancing type electronic recorder. As alpha emitting source attached in each ionization chamber, 100 micro-curies of Ra(D + E + F) is used.

Results of performance tests made in laboratory are summarized as follows: under constant atmospheric condition, both RI-methanometers proved sufficient accuracy to given methane concentration, pressure compensating chamber proved its validity to eliminate the effects of changes in atmospheric pressure, rapid changes in air temperature gave a zero-point shift to RI-methanometer, especially one for lower concentration (some modifications will be made further to improve this defect), and this methanometer also is not an exceptional one against the effects of other gases in sampled air, as was predicted from the basic experiments. (auth)

16215 TRIAL CONSTRUCTION OF A METHANE METER EMPLOYING A RADIOISOTOPE. Matsukuma, Yoshifusa; Oba, Sigeyoshi (Resources Research Inst., Kamaguchi, Japan). Nippon Kogyo Kaishi, 82: 3104-5 (Mar. 1966). (In Japanese).

The feasibility of constructing a methane meter employing an ionization current due to the passage of α -particles in the mine air was previously reported. An RI methane-meter capable of measuring the methane concentrations of 0 to 10%, and another with a high-gain dc amplifier for extending the scale range from 0 to 10% were constructed in trial. It consists of Ra as the source of α -particles, an ionization chamber for the measurement of a methane concentration and another ionization chamber for the compensation of the ambient condition, a vibration capacitance type electrometer (YEW, VM-16) a 100 μ A. dc meter, an alarm, and out-put terminals for the automatic balancing recorder. The electrode voltage (200V) for the ionization chambers and the radioactivity (100 μ Ci) of the Ra source were selected so as to give satisfactory linearity, intensity and reproducibility of the response. Although the response of the methane meters is not affected by the variation of room temperature ($\pm 5^\circ\text{C}$) and of atmospheric pressure (± 500 mmHg), the methane meter with the scale range of 0-10% methane concentration is slightly influenced by the variation of room temperature. The results given by the meters agreed with the results of the interference-type methane-meter. (NSA of Japan)

4745 OPERATIONAL PRINCIPLE AND DESIGN OF AN IONIZATION SMOKE-GAS SIGNAL SYSTEM. Voté, Kh. K.; Shultse, Kh.; Khilbig, Kh.; Nenniöff, N. (Inst. of Applied Radio-activity, Leipzig). 12p. (In Russian). (CONF-641024-9). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

A smoke detector was designed which is based on the significant decrease in the ionization current in an ionization chamber when smoke enters the chamber due to neutralization of the ions by sub-microscopic particles. The detector case is made of polystyrene for impact resistance. Inside the case are located two ionization chambers and the lamp of an electrometer. Krypton preparations of 2 μ Ci activity carry the 0.1 amp current. This activity is selected to meet radiation safety regulations but still provide high sensitivity. The current needed for operation is 1.5 ma. The operating voltage may be varied within the limits 200 to 280 volts. Tests on the instrument showed that it began to operate within several minutes in response to a change in temperature 5 meters away. (TTT)

16073 RADIOISOTOPES SPEED FIRE DETECTION. Dance, J. B. (Univ. of Aston, Birmingham, Eng.). Instrum. Pract., 20: 975-8 (Dec. 1966).

The use of radioisotopes in smoke detection devices is reviewed. Smoke detectors employ ionization chambers containing a small source of α radiation (usually ^{226}Ra or ^{241}Am) of 10 to 100 μ Ci in activity. If smoke enters such a chamber, some of the ions formed in the air by the α radiation will approach smoke particles and give up their charge. Thus when smoke enters an ionization chamber, the current passing through the chamber tends to decrease. An additional very small reduction in the ionization current is due to the absorption of the α radiation by the smoke particles. Two ionization chambers are employed in the smoke detecting devices. The wall of one is of wire mesh through which the smoke particles can enter, but the other chamber is closed. Changes which occur in the circuit potentials when smoke particles enter the open chamber applied to a trigger electrode cause the gas in the tube to ionize. The resulting anode current (about 15 mA) operates a relay which in turn actuates warning devices and any fire extinguishing equipment. The ionization chamber detector is sensitive to particles larger than air molecules. Such particles are often too small to be visible as wisps of smoke. (BBB)

4705 MODE OF OPERATION, DESIGN, AND PROPERTIES OF AN IONIZATION-CHAMBER FLUE-GAS INDICATOR USING

^{85}Kr SOURCES. Schulze, H. W.; Bothe, H.-K.; Nenoff, N. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Isotopen-praxis, 2: 381-5 (Oct. 1966). (In German).

Measurements were made on the decrease of ionization current by flue gas of a defined kind and amount in an ionization chamber. An ionization-chamber flue-gas indicator is described, which can be used without any provisions for radiation protection. The mode of operation and the effect of vapors, aerosols, fog, or powder on the operation of this indicator are discussed. (auth)

Moisture

14486 MEASUREMENT OF HUMIDITY BY THE SLOWING DOWN OF FAST NEUTRONS. Boirat, R. Ann. Radioelec., 22: 51-8 (Jan. 1967). (In French).

Humidity is a very important parameter in many industrial processes. It has to be determined when preparing products with a specified degree of humidity, when mixing constituents in definite proportions, and it is the concern of very many industries. Foundry sand, concrete, ceramic materials are products of which the degree of humidity has to be adjusted at a constant value. The glass industry, agglomeration plant also need this factor. A method of measurement is described using the slowing down of fast neutrons which is particularly applicable to problems arising in modern industry. (tr-auth)

4459 ESTIMATION OF MOISTURE CONTENT BY NEUTRON-SCATTERING: THEORY, CALCULATION, AND EXPERIMENT. Gemmell, W.; McGregor, B.; Moss, G. F. (Australian Atomic Energy Commission, Lucas Heights. CSIRO, Melbourne). Int. J. Appl. Radiat. Isotopes, 17: 615-20 (Dec.).

The moisture content of various cement products was determined, using a surface probe technique, and the results were interpreted using the Boltzmann transport equation, which was solved numerically on a digital computer in multi-energy group form. It was found that it is necessary to consider the density and type of all nuclei present in the materials under investigation in order that the technique may be described adequately. (auth)

4722 MOISTURE MEASUREMENT UNDER FIELD AND INDUSTRIAL CONDITIONS WITH NEUTRON GAGES. 8p. (In Russian). (CONF-641024-3). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

The slowing down of fast neutrons by hydrogen atoms is proportional to the amount of hydrogen, and thus of water, present and may be used for nondestructive determination of hydrogen or water. The neutron source should give a high neutron yield and a small gamma output and should have a long half life, for example americium-beryllium and plutonium-beryllium. The detector should have a high sensitivity, temperature stability, compactness, and ruggedness. Two moisture gages are described, and examples of uses are given, for example, for determining moisture in sand to improve the quality of concrete or glass made from it; moisture in lime or fertilizer on a conveyor belt to ensure product quality; and hydrogen concentrations to find the density of a silicate foam or the amount of a hydrocarbon present. (TTT)

10688 MOISTURE GAUGE CALIBRATION BASED ON THE DISTRIBUTION OF NEUTRONS SCATTERING IN CONSTRUCTION MATERIALS. Apostol, E. (Inst. of Atomic Physics, Bucharest). Nucl. Eng. Design, 4: 322-8 (Oct. 1966).

The counting rate, measured by a counter with BF_3 , for slow neutrons scattering in material containing water, is presented under three terms. The counting rate given by the theory of neutron transport in water is used as the first term; the counting rate obtained on dry and homogeneous test material is used as the second, and the apparatus background counting rate as the third term. The average distance between source and counter is established by means of a nomogram in terms of moisture. The influence correction of the drill hole diameter is realized by multiplying the counting rate by a cavity factor obtained from the ratio between the counting rates for a certain cavity and those for the reference cavity. By utilizing the proposed method of measuring the above-mentioned three counting rates and the counting rate of a test material with known moisture, the radiometric moisture gage can be easily calibrated without using the classical calibration method, which is very difficult to apply for a great number of points in the entire moisture measuring range. The proposed

method is checked by comparing the calculated calibration curve with the experimental curve for two average distances between source and counter, and for different materials like: soil, sand, aggregates, and cement concretes. (auth)

6323 INFLUENCE OF BULK DENSITY OF THE SOIL ON NEUTRON MOISTURE METER CALIBRATION. Holmes, J. W. (CSIRO, Adelaide). *Soil Sci.*, 102: 355-60 (Dec. 1966).

A method is described for calibrating a neutron moisture meter by including all the hydrogen content of the soil and expressing it as equivalent water content by volume (θ), and by adjusting the observed counting rate (n_1) to a value (n_2), which it would have in a soil possessing the macroscopic cross section for absorption of slow neutrons of the undisturbed soil. However, the improvement is so slight that the adjustments described would be worth making only when it is desired to push to the limit the resolution of the method for distinguishing change in water content. Also, there seems to be no alternative to individual calibration of each soil intended for investigations. (P.C.H.)

12757 DETERMINATION OF EVAPOTRANSPIRATION USING THE NEUTRON-SCATTERING METHOD. Bowman, D. H.; King, K. M. (Ontario Agricultural Coll., Guelph). *Can. J. Soil Sci.*, 45: 117-26 (June 1965).

An evaluation was made of the measurement of evapotranspiration (ET) by the neutron-scattering method under certain field conditions, its accuracy, and limits of its application. A Nuclear Chicago P-19 depth probe, P-21 surface probe, and 2800 scaler were used to measure the soil moisture. Measurements were taken weekly from June to September in unirrigated and irrigated corn and wheat seeded with clover. It is concluded that the neutron scattering method described is an easy and satisfactory means of estimating the ET of crops growing in undisturbed soil. The method was found accurate to 0.15 in. of water for 1 week, or 0.62 in. over a 3-month period, using only one site in a gravelly soil. The error is reduced considerably, however, by averaging over several sites and by measuring the percolation or capillary rise more carefully, using the technique suggested. The accuracy gained by taking readings longer than 2 min at each soil depth is small, however, in view of the non-uniform moisture distribution within the soil. Application of this method to other soils and conditions appears feasible. Careful attention to the effects of surface flow, percolation, capillary rise, lateral movement, deep-rooted plants as well as instrument calibration is essential to accurate determinations of ET by the neutron-scattering method. (BBB)

17906 DETERMINING THE MOISTURE OF SUBSTANCES BY NEUTRON RADIATION. Dresia, Heinrich; Fischotter, Peter; Bessing, Reinhold (Rheinische Kalksteinwerke GmbH). *British Patent 1,063,477*. Mar. 30, 1967. Filed Sept. 13, 1963.

An apparatus for determining the moisture content of solid substances by neutron radiation consisting of a fast neutron source with a relatively short lifetime, and a thermal neutron-counting device such as a BF_3 counter is described. The BF_3 counter is partially encased in Cd which is progressively removed as the source decays. Hydrocarbon material such as synthetic plastic or resinous material is employed as a solid reflecting material. (F.S.)

6325 MEASUREMENTS WITH NEUTRONS. A FURTHER AREA OF APPLICATION IN MOISTURE DETERMINATION AND ACTIVATION ANALYSIS. Kosmowski, A. (Frieske and Hoepfner GmbH, Erlangen-Bruck, Ger.). *VDI (Ver. Deut. Ing.) Nachr.*, 19: 7 (Oct. 1965). (In German).

The fundamentals of theory and techniques of analysis by neutrons are reviewed. A method of analysis of ground water by neutron moderation is presented, with the use of a Ra-Be source which measures sample density by γ radiation and moisture content by neutron radiation; one device measures content at the surface; a deep sound measures water content at depths to 20 m. Each sound consists of a neutron counter coupled directly to a 10-mCi Ra-Be source for deep samples, or a 2-mCi source for surface measurements. Results are obtained directly with precision of 1% in a nondestructive fashion. Several applications of the technique are suggested. Activation analysis is briefly described and compared in sensitivity with standard chemical methods. Problems of sources for such studies and the sensitivity of the method for different elements are discussed. Several areas for application are listed. Illustrations of the apparatus for ground density and moisture content are given. (BBB)

Moisture and Density

4718 CONTINUOUS RADIOMETRIC MEASUREMENT OF THE DENSITY AND MOISTURE OF CERAMIC PRODUCTS. Holzhey, J.; Schwarzlose, J. (Forschungsinstitut fuer NE-Metalle, Freiberg i. B.). *Isotopenpraxis*, 2: 387-90 (Oct. 1966). (In German).

In producing ceramic materials the moisture of the raw product must be kept as constant as possible. The usually continuous production process calls for a sufficiently rapid moisture measuring method. Since there is a direct connection between moisture and density of ceramic intermediate products, moisture control by density measurement suggests itself (moisture determination by means of neutrons being unsuitable for various reasons). A measuring arrangement and the results obtained in the application of a weight per unit area gage, VA-T-70A, are discussed. (auth)

185 MEASUREMENT OF DENSITY AND MOISTURE USING RADIONUCLIDES. Kosmowski, A. (Frieske and Hoepfner, Erlangen, Ger.). *Instrum. Pract.*, 20: 669-72 (Aug. 1966).

The use of radionuclides for gaging and controlling density and moisture is reviewed. When different kinds of liquids, e.g., raw oil, fuel oil, or gasoline are transported in pipelines, it is possible using radionuclides to measure continuously the density variation and thus to establish changes in the liquids being transported. The measurement is based on the principle of absorption of nuclear radiation in liquids, the degree of absorption depending on the density. The radiation from the radioactive source penetrates diametrically through the pipe and, after having been partly absorbed, reaches the measuring chamber. The electrical impulses from ionization are fed into an amplifier and are indicated on a calibrated instrument. Sources of ^{60}Co and ^{137}Cs with half-life periods of 5.2 and 30 yr respectively are suitable. It is possible to make density measurements on pipelines of 200 to 1000 mm dia. This measuring process has the advantage that even corrosive liquids can be measured without sampling. Coarse suspensions can also be measured without difficulty. The uncertainty of measurement is 2% of the measuring range and not less than 0.001 g/cm³. Another important use of density measurement with nuclear radiation is the determination of solid content and solid handling rate of suction dredges. During manufacture or preparation of bulk materials such as foundry molding sand, sinter ore mixture, constituents for concrete, glass and ceramics it is important to control the moisture content. The equipment used comprises a moisture primary element, an industrial ratemeter, and a source holder with an Am-Be neutron source having an activity of 100 mC. High speed neutrons emitted by the source are slowed down depending on the proportion of H in the material under test. Resulting thermal neutrons are proportional to the moisture content of the material under test. Elements which readily absorb the neutrons such as B, Cd, and certain rare earths should be eliminated from the material to be measured (interference above 1 ppm may occur). The content of coal and O should not vary greatly. If the measuring probe is uniformly surrounded by the material to be measured, there will be a linear relation between the measuring signal and the moisture. (BBB)

Density

1661 ON THE MEASUREMENT WITH GAMMA-RAYS OF THE DENSITIES OF COAL PILES AT THE MATSURAMA POWER STATION. Ono, Hironori; Machida, Tadao (Central Research Inst., Electric Power Industry, Tokyo). *Gijutsu Kenkyusho Shoho*, No. 65018, 1-29 (June 1965). (In Japanese).

Density measurements were made on coal to determine density distribution in a compressed coal pile. Gamma surface measurements were compared to those made by conventional boring methods. Values made by boring showed an error of 6.2% caused by the space between the guide tube and the surrounding coal. Boring values were larger than surface α -ray measurements. To obtain the average density with the γ -ray method, with a reliability of 95% within 1% error, it is necessary to use about 200 measuring points. (F.S.)

14400 DETERMINATION OF DENSITY OF LARGE-AREA CONCRETE CONSTRUCTION ELEMENTS BY USING THE GAMMA-RAY TRANSMISSION TECHNIQUE. Pohl, E. (Hochschule fuer Bauwesen, Leipzig). *Isotopenpraxis*, 2: 454-8 (Dec. 1966). (In German).

Density is an important factor for construction elements of concrete utilized as the elements of outer walls because of its decisive influence on the thermal insulating properties. At present, no nondestructive method of materials testing is known which permits control of homogeneity and density of large-area construction elements. Using the gamma-ray transmission technique makes it possible to determine the density with a relative accuracy better than $\pm 3\%$. The errors of measuring due to changes in geometry are given and some measuring devices proved accurate in practice are described. (tr-auth)

3334 CONSTRUCTION OF RADIOMETRIC DEVICES FOR INDUSTRIAL GEOPHYSICS AT THE PETROLEUM INDUSTRY'S GEOPHYSICAL ESTABLISHMENT IN KRAKOW. 7p. (In Russian). (CONF-641024-4). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

A two-channel radiometric probe is made for simultaneous logging of boreholes by the gamma and neutron-gamma methods. The maximum operating temperature is 100°C . The two models of the probe have diameters of 102 and 75 mm, respectively, and allowable pressures are up to 600 kg/cm^2 . A small scintillation probe for gamma, neutron-gamma, and neutron-neutron logging makes measurements faster than a probe with a G-M counter. A three-channel surface-based radiometric panel is made for simultaneous measurements of three different parameters. A "cementometer" was designed and manufactured in 1963 for determining the characteristics of cemented boreholes with a diameter of $6\frac{1}{8}$ in. by a gamma-gamma method. It has three independent channels. Data on all the described instruments are presented. (TTT)

1665 HIGH-PRECISION GAMMA DENSITOMETER. Lakoshi, L.; Tabor, P.; Tot, M. 7p. (In Russian). (CONF-641024-2). ORAU.

From Symposium on Use of Radioisotopes, Warsaw.

Density gages based on absorption of radiation from radioisotopes, which have a precision of 10^{-2} g/cc , have been used since 1950. A new gage that has a precision of 10^{-3} to 10^{-4} g/cc is a complex system supplied with accessory compensating equipment. The detector is a 1 liter ionization chamber filled with argon at 125 atm pressure. The chamber sensitivity in the energy range 0.2 to 1.5 MeV is about $1.3 \times 10^{-8}\text{ amp/R/hr}$. The thermostatic data unit contains the detector, preamplifier, and high-voltage unit. The electronic amplifier is the most modern type of dynamic electrometer and ensures a long-lived electronic system, high precision in measurement, and dependability in constant use. A compensating voltage unit balances the voltage at the operating resistance of the ionization chamber and makes it possible to set the limits of measurement where desired. Formulas are developed for the relation between current generated and gamma quanta (for ^{60}Co and ^{137}Cs sources) and for handling errors. (TTT)

3333 QUANTITATIVE RELATIONS IN THE APPLICATION OF DEPTH AND SURFACE-EQUIPMENT FOR SOIL DENSITY MEASUREMENTS BY SCATTERING OF GAMMA RAYS. Kuehn, W. (Technische Hochschule, Hanover). *Kerntechnik*, 8: 496-9 (Nov. 1966). (In German).

A simple and clear representation of the radiation intensity on the detector can be obtained as a function of the geometry, density, energy, or atomic number, and ratio of atomic number to mass number from space distribution of the energy absorbed in the scattering medium for depth and surface equipment in soil density measurements. The intensity scattered in the direction of the detector and the important input magnitudes were derived for such a detector. The results obtained were compared with known experimental results. (J.S.R.)

3329 INVESTIGATION OF THE BEHAVIOR OF A WET-STEAM TURBINE BY MEANS OF RADIOMETRIC METHODS. Loeffler, H. (Technical Univ., Dresden). *Isotopenpraxis*, 2: 361-4 (Sept. 1966). (In German).

Measuring equipment and methods are described for the determination of local steam-density distribution in a wet-steam turbine. From the measured density distributions conclusions are drawn about the behavior of the turbine investigated. (auth)

6090 GEOPHYSICAL WELL LOGGING IN IRON ORE EXPLORATORY DRILLINGS. Karasne, Tamas Zsuzsa. *Geofiz. Kozlem.*, 15: 205-14 (1966). (In Hungarian).

The utilization of gamma spectrometry with neutron capture in the detection of ore bodies in the area of Rudabanya iron ore deposits is reported. Results of the laboratory and downhole application of this method are presented. (auth)

6022 INVERSE PROBE DIAGRAMS FOR NEUTRON-NEUTRON LOGGING OF VARIOUS SEDIMENTARY ROCKS. Belomar, O. D.; Bardovskii, V. Ya.; Arkhangel'skii, V. E. (Inst. of Mineral Resources, Simferopol, USSR). *Izv. Akad. Nauk SSSR, Fiz. Zemli*, No. 10, 105-6 (1966). (In Russian).

Quantitative data are given for the inverse logging obtained by statistical evaluation of the neutron-neutron γ logging of 17 holes drilled in Perm rocks. The rocks consisted of rock salt, anhydrite, gypsum, argillite, sandstone, limestone, and dolomite. Measurements were made in holes (110 to 120 mm in diameter) filled with saturated NaCl solution by using a logging radiometer with slow neutron detectors with zinc sulfide and boron (^{10}B). The neutron-neutron logging diagram for extensive probing (60 cm) in the rock salt is fixed by higher thermal neutron values because of the more extensive length of neutron migration than in other associated rocks. The graphs may be used for evaluating inversion probes and for comparison of probe efficiency in neutron-neutron logging. (R.V.J.)

1666 MINERAL MINING MACHINES. Cooper, Laurence Reade; Lawrence, Geoffrey Albert (to Coal Industry (Patents) Ltd.). British Patent 1,045,874. Oct. 19, 1966. Filed Apr. 19, 1962.

A mineral mining machine consisting of a γ -ray or x-ray source and a scintillation counter is responsive to radiation backscatter from material adjacent to the machine. Radiation from the source is directed into the adjacent mineral and part of the backscattered radiation impinges on the counter. The source and counter are mounted adjacent to each other in a radiation shield. The machine is used in steering, cutting or drilling machines in coal seams. Thulium-170 and ^{241}Am are suggested as radiation sources. (F.S.)

Thickness

16074 RADIOACTIVE PROCEDURES FOR MEASUREMENT OF FILM THICKNESS. PART V. Kosbahn, Thomas (Arolsen, Kreis Waldeck, Ger.). *Arch. Tech. Messen.*, No. 371, 365-8 (Dec. 1966). (In German).

Thickness measurements of fluids in tubes using β and γ radiations are discussed and illustrated. These measurements are used in the petroleum industry to follow flow and mixing of fuel components. Measurement uncertainty is plotted as % of density for ^{90}Sr , ^{137}Cs , and ^{60}Co . Doses at various distances are plotted for ^{147}Pm , ^{204}Tl , and ^{90}Sr . Factors such as the no. of curies, type of radiation, max energy, frequency of γ radiation, half life, and shielding conditions that effect the radiation hazard from thickness measurement procedures are discussed. Pertinent industrial procedures to ensure safe use of high intensity radiation sources are presented and discussed briefly. Forty three references are cited. (BBB)

14489 DETERMINATION OF THE THICKNESS OF THIN LAYERS. Schaerf, K.; Vuorinen, A. (International Atomic

Energy Agency, Vienna). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/62, 16p. (CONF-661012-43). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

When radioactive sources are counted on an absolute basis the sources are often mounted on thin uncoated or coated films. Usually the experimenter needs to know the thickness both of the film and of the coating. An alpha particle thickness gauge is described where the energy loss of ^{241}Am α -particles in films is used as a measure of the thickness. Measurements are made under vacuum and the α 's are detected by a surface barrier detector. This system is applicable for film thicknesses from a few $\mu\text{g/cm}^2$ up to some mg/cm^2 . For foils up to $200\text{ }\mu\text{g/cm}^2$, the accuracy is $\pm 1\text{ }\mu\text{g/cm}^2$. The calibration is done by weighing. Some experiments are also described where film (VYNS) thickness and the thickness of evaporated metal (Au) coating on it was determined by the x-ray fluorescence method. Experiments were checked by weighing and by activation analysis. Results showed that this method is applicable within a range of 1 to $100\text{ }\mu\text{g/cm}^2$. (auth)

14485 (NP-tr-1477) THICKNESS-MEASURING DEVICE BASED ON RADIOACTIVE SOURCES FOR AUTOMATIC GAGING OF FILMS AND SHEETS DURING PRODUCTION. Loznovskii, Yu. Ya. Translation of Radioaktivnyi Tolshchinomer Dlya Avtomaticheskogo Kontrolia Tolshing Plenochnykh i Tistovykh Materialov v Protseesse Ikh Izgotovleniya. 19p. (TT-65-50134, IPST-Cat.-1430). Dep. mn. CFSTI \$3.00 cy, \$0.65 mn. JCL \$1.60 fs, \$0.80 mf.

The radiation thickness gage is described which can be used for the noncontact continuous thickness measurement of materials of different chemical composition and density. By a suitable choice of radioisotopes and modification of the construction of the measuring unit it is possible to measure the thickness of various areas of different plastic and sheet materials. Using sources of a narrow rectangular shape one can measure the thickness of narrow strips of material. Using point-type radiation sources one can measure an area of several square millimeters. The radiation thickness gage is of simple construction, comparatively inexpensive to produce, and does not require skilled service personnel. The thickness gage, in use since August 1961 till the present, has proved that the electronic circuitry is reliable, and that the whole maintenance consists mainly of the timely replacement of electronic tubes. (auth)

14487 RADIOACTIVE PROCEDURES FOR MEASUREMENT OF FILM THICKNESS. PART I. Kosbahn, Thomas (Arolsen, Kreis Waldeck, Ger.). Arch. Tech. Messen, No. 367, 169-74 (Aug. 1966).

The nature and characteristics of α radiations in terms of velocity, specific ionization, and energy are compared with mass density. The use of α radiation for density measurements is illustrated by a probe type instrument that uses an ionization chamber for measurement. Properties of β emitters, such as max energy, max range, and half value layers, are compared to indicate their use for thickness measurements. The nature of β radiation is reviewed, and their ranges and max energies are depicted graphically. Absorption curves are compared, and the mass absorption coefficient is plotted as a function of the max energy of several β emitters. Various mathematical relations are derived to indicate the suitability of β emitters for thickness measurements. (BBB)

14488 DETERMINATION OF ALUMINA FILM THICKNESS BY ALPHA PARTICLE SCATTERING. Pelsach, Max; Poole, Darrell O.; Roehm, Hermann F. (Southern Universities Nuclear Inst., Faure, Africa). Talanta, 14: 187-94 (Feb. 1967).

The scattering of accelerated alpha particles was used to determine the surface oxide film thickness of anodized aluminum. The measurements were based on determining the difference between the energy of an alpha particle scattered from the surface oxide layer and that from the underlying metal. Films ranging in thickness from 10 to 130 $\mu\text{g}/\text{cm}^2$ were analyzed non-destructively with a relative standard deviation of 3.5%. The average time for an analysis was 30 min with an incident beam current of up to about 1 μA . (auth)

13763 (NP-16501) ETUDE PRELIMINAIRE DU DOSAGE PAR FLUORESCENCE X DE COUCHES MINCES D'ERBIUM ET DE TITANE. (Preliminary Study of X Fluorescence of Thin Layers of Erbium and Titanium). Pluchery, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Aug. 1965. 15p. (In French). Dep. mn.

The precision with which the thickness of very thin layers of Ti and Er can be deposited on supports of Cu or Ag to be used as accelerator targets was evaluated. The selection of the optimum measurement conditions was studied and the limit of detection and of the precision was evaluated. The preliminary results show that the detection limit for the thickness of the Ti layers would be 2 and 1.3 $\text{\AA}$ for Cu and Ag respectively with a precision of 1.7 and 1.2 $\text{\AA}$ respectively. For Er a detection limit of 1.7 and 1.3 $\text{\AA}$ was found respectively for Cu and Ag and a precision of 1.3 and 1 $\text{\AA}$ respectively. These results can be considered only as an order of magnitude valid by a factor of two. (J.S.R.)

8532 RADIOACTIVE MEASUREMENT TECHNIQUES FOR THE WEIGHT OF SURFACES. PART II. Kosbahn, Thomas (Arolsen, Kreis Waldeck, Ger.). Arch. Tech. Messen, No. 368, 193-8 (Sept. 1966). (In German).

The use of the β radiator is described in terms of the choice of source radiation detector, effects of the geometric arrangement of source and detector, technological applications and procedures, and backscatter procedures. Theoretical and practical descriptions are given of equipment and procedures of an ionization chamber for thickness measurement, comparison of the numbers of ion pairs for α and β radiation as a function of voltage, schematic diagram of a radiation densitometer, principle of a compensating circuit with two ionization chambers, commercial source-detector equipment, equipment compensated for continuous measurement of thickness of plastic tubes or pipes with β radiation, arrangement of an ionization chamber for measurement of backscattered β radiation used for measurement of thickness of rubber sheeting with thickness d on a steel drum of thickness D , and the backscatter energy as a function of the steel drum thickness and rubber sheeting thickness. The saturation thickness is reached with the steel drum, but the rubber sheeting must be measured below its saturation value. (BBB)

8533 RADIOACTIVE MEASUREMENT TECHNIQUES FOR WEIGHT OF SURFACES. PART III. Kosbahn, Thomas (Arolsen, Kreis Waldeck, Ger.). Arch. Tech. Messen, No. 369, 217-20 (Oct. 1966). (In German).

The nature of bremsstrahlung is discussed. The dependence of the bremsstrahlung spectrum on the thickness of an irradiated Pb target is illustrated by spectra for ^{147}Pm , ^{85}Kr , and $^{90}\text{Sr}/^{90}\text{Y}$ sources and different thicknesses of target. The absorption curve for bremsstrahlung from $^{90}\text{Sr}/^{90}\text{Y}$ through steel is shown to be a sensitive measure of thickness. Illustration and discussion of available devices for application of bremsstrahlung are given. The nature of γ radiation is discussed. Linear diminution coefficients of γ rays in Pb as a function of radiation energy are given, and the coefficients are divided into the photoeffect, Compton effect, and pair production components. The mass diminution coefficients are also given and similarly divided. A table of γ emitters for surface mass measurements is given, including pertinent properties of ^{170}Tm , ^{75}Se , ^{182}Ir , $^{137}\text{Cs}/^{137}\text{Ba}$, ^{182}Ta , ^{60}Co , and ^{228}Ra . (BBB)

12698 RADIOACTIVE PROCEDURES FOR MEASUREMENT OF FILM THICKNESS. PART IV. Kosbahn, Thomas (Arolsen, Kreis Waldeck, Ger.). Arch. Tech. Messen, No. 370, 241-4 (Nov. 1966). (In German).

The application of γ radiations to measurements of film thickness, including factors that affect the choice of γ emitter, the radiation detector, optimal geometric arrangement, and procedures that are pertinent to use of penetrating radiation for measurements on steel rolling stock are discussed. Statistical variations inherent in these procedures are derived. Measurement sensitivity and preparation activity is plotted as functions of steel thickness. Backscatter procedures are discussed. Pulse frequency and measurement uncertainty as a function of steel thickness for γ backscattering is illustrated for a photomultiplier-sieve amplifier arrangement. A light pipe-photomultiplier-cathode follower array for γ backscatter measurements is described. Backscatter intensity as a function of angular distance for steel plates and tubes is plotted in arbitrary scale units, and using steel thickness as a parameter, backscatter intensity is plotted as a function of plating thickness. Backscatter intensities for ^{137}Cs and ^{60}Co are compared as a function of steel thickness. (BBB)

19860 APPLICATION OF THE LOW ACTIVITY ISOTOPIC SOURCES TO CONTINUOUS CONTROL OF THICKNESS OF THE THIN METALLIC COVERINGS AND DIAMETERS OF WIRES, BY MEANS OF THE X-RAY FLUORESCENCE. Bednarek, Boguslaw; Jelen, Kazimierz; Ostrowski, Kazimierz (Instytut Techniki Jadrowej, Krakow). Nukleonika, 12: 135-41 (1967). (In Polish).

Geometric conditions for thickness gages for metallic coverings and wires, such that the signal in same interval of lengths (20 to 40 mm) does not depend on the sample-counter window distance, were established. Two solutions of the problem were pointed out: application of the counter with the screen blinding central part of the window, and using the point source or annular one with the experimentally chosen radius. The advantage of this method is the capability of performing measurements of covering thickness of the metallic plates, and diameters of wires, when the distance sample-counter window alternates. The method requires source of radiation of the relatively low activities (e.g., 100 μCi). (tr-auth)

Level

3330 DESIGN OF RADIATION RELAYS USED FOR THREE-POSITION CONTROLLERS IN NON-COMPENSATED CONTROL LOOPS WITH DEAD TIME. Irmer, K. (Technical Univ., Dresden). *Isotopenpraxis*, 2: 358-61 (Sept. 1966). (In German).

The design of radiation relays used for three-position controllers in simple control loops for measurement and level control is described. On the basis of the dead time of the radiation relays an optimal design of the radiation relays is determined. This permitted the use of the smallest activity of the radiation source. (auth)

238 MODIFIED METHOD FOR THE DETERMINATION OF AQUIFER PARAMETERS USING RADIOACTIVE ISOTOPES. Hazzaa, I. B. (Middle Eastern Regional Radioisotope Centre for the Arab Countries, Cairo). *Int. J. Appl. Radiat. Isotop.*, 17: 583-5 (Oct. 1966).

The method for measuring the lowering of water levels in wells during pumping was modified to overcome the difficulties that appeared during several field experiments. A γ source placed outside the well is connected through a set of pulleys to a float on the water surface in the piezometer well; and variation of the counting rate caused by elevating the source due to the lowering of the float when pumping from a nearby well is registered using a scintillation detector. The method was applied on deep wells and lengthy draw-downs giving prompt and sensitive register. (auth)

Hardness

1667 MEASURING HARDNESS BY USING BETA RADIATION. Varner, Donald Edmund (to Industrial Nucleonics Corp.). British Patent 1,038,998. Aug. 17, 1966. Filed Sept. 6, 1963.

A nondestructive hardness gage is described in which a beam of β particles is directed to a metallic demagnetized workpiece having substantially homogeneous composition. The backscattered radiation is detected by a radiation detector which is calibrated to provide an electric signal proportional to the intensity of the reflected or backscattered radiation. Krypton-85 is suggested for the β source and an ion chamber for the detector. (F.S.)

Radiography

14386 (AAEC-TM-309) SELECTION OF RADIATION SOURCES IN RADIOGRAPHY. Chrimes, N. W. D.; Wright, W. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1965. 27p. Dep. mn.

The characteristics required of a radiation source for radiography are: the wavelength of the beam must be suitable, considering the thickness and absorption coefficient of the material under examination, to obtain adequate contrast in the radiograph; the beam must have a high intensity to reduce the exposure time; and the source should be of small diameter to reduce geometric unsharpness of the image. These optimum conditions are readily obtained with x-ray generators. With isotopes, the beam intensity is usually lower than that attainable with x-ray generators and the wavelengths of the beam are decided by the initial choice of isotope. Consequently the exposure times required for isotopes are relatively long compared with those used in x-radiography. The comparative absence of gamma emitters with energies in the range 0.1 to 0.4 MeV means that sensitivities will be relatively poor for the range of materials and thicknesses most frequently encountered. The advantages of isotope sources are the low capital investment required and their convenience in use under conditions where no electricity and water are available or where it is impossible to locate an x-ray source. The characteristics of a number of isotope sources are discussed in relation to their potential for radiography. (auth)

243 PRINCIPLES AND APPLICATIONS OF THE γ -RADIOGRAPHY APPARATUS (TYPE GAMMAMAT) FOR MATERIAL TESTING. Sauerwein, K. (Institut fuer Gesteinshuettenkunde der RWTH, Aachen. Forschungsinstituts der Feuerfest-Industrie Bonn, Aachen). *Deut. Keram. Ges.*, 13: 467-62 (June 1966). (In German).

Gamma radiography is described and contrasted with x-ray and ultrasonic testing. The most common γ ray

emitters are reviewed. Three principal types of radiographic equipment are described. Applications of radiographic techniques include investigation of the texture of structural units, concrete making, welding, determination of density, porosity, moisture content of structural materials, and testing materials for cavities and foreign inclusions. (R.C.K.)

19875 GAMMA-RAY NONDESTRUCTIVE TESTING OF MATERIALS. Freyer, G. (Otto von Guericke Technische Hochschule, Magdeburg, Ger.). *Isotopenpraxis*, 3: 1-7 (Jan. 1967). (In German).

Various applications of gamma-ray defectoscopes for nondestructive materials testing are reviewed. The gamma-ray testing method is described as to theoretical foundation, application of different sources and source containers to the device, experimental results of materials testing using the device, and an evaluation of the uses of this technique. (L.C.L.)

4720 ISOTOPE FLAW DETECTORS FOR INVESTIGATING WELDED PIPE SEAMS AND BOILER ELEMENTS. Koteski, Stanislav. 4p. (In Russian). (CONF-641024-14). DTIC.

From Symposium on Use of Radioisotopes, Warsaw.

Descriptions are given of six isotope flow detectors: a 10 Ci ^{192}Ir source detector mounted on a carrier and inserted into a pipe for checking welded seams; a detector operating with a ^{137}Cs source and mounted into a holder capable of reaching less accessible points; a detector with a ^{192}Ir source activity of 5g equiv Ra placed in a mercury filled lead casing used for examining the periphery of pipe seams; a detector with ^{192}Ir activity of 2g equiv Ra used for a corkscrew method of pipe examination; a 10 Ci ^{192}Ir source detector contained in a 75 mm lead container used for examining less accessible places; and the alligator, a 2 x 2 mm detector with 8.5 Ci ^{60}Co source designed for checking thick-wall pipe seams. (TTT)

10551 ^{192}Ir GAMMA RADIOGRAPHY. II. Tsujimoto, Tadashi; Sumino, Teruie (Kyoto Univ.). *Genshiryoku Kogyo*, 12: 60-2; 71 (Mar. 1966). (In Japanese).

Iridium-192 with both x and γ rays is widely used as a source for the nondestructive tests. The advantages and disadvantages of ^{192}Ir radiography are described. The contrast in a radiograph is given by $\Delta G = G \log (I_A/I_B)$, where I_A and I_B are the intensities of gamma-rays transmitted through the thicknesses D_A and D_B , respectively. The ^{192}Ir gamma source was found to give the best results. Some of the advantages of the ^{192}Ir gamma source are as follows: the preparation of a high-intensity radiation source of small size is easy; the nondestructive testing apparatus can be small and light due to its simplified shielding; a good contrast is obtained; the ^{192}Ir radiography is applicable to a large variety of objects; and the source is most suitable for the thicknesses of materials which are tested most often. The primary disadvantage of ^{192}Ir is its short half life (74.4 days). (NSA of Japan)

10550 ^{192}Ir GAMMA RADIOGRAPHY. I. Tsujimoto, Tadashi; Sumino, Teruie (Kyoto Univ.). *Genshiryoku Kogyo*, 12: 55-8 (Feb. 1966). (In Japanese).

In the radiographic method for detection of defects and flaws in steel products, x-ray generators, γ -ray sources and accelerators such as betatrons are used as the radiation sources. X rays are used for relatively thin products and γ rays (^{60}Co , ^{137}Cs) for thick products, while ^{192}Ir γ rays are particularly useful for products of intermediate thicknesses. Because of its excellent discrimination and striking contrast in radiographs, about 60% of the nondestructive testing sources are ^{192}Ir at the present. However, the half life of ^{192}Ir is short (74.4 days), and therefore, it is necessary to regenerate it in nuclear reactors. The results of various calculations and experiments made on ^{192}Ir are described. An ^{192}Ir nondestructive testing source was prepared by sealing 99.9% iridium powder in an aluminum cylinder. Although ^{192}mIr , ^{28}Al and ^{194}Ir activities are induced during the activation in a reactor, they all decay out within a week after activation. The activation conditions for preparation of ^{192}Ir in the desired intensities, the intensity and dose rate of the gamma rays, and the absorption in the shielding materials are discussed. (NSA of Japan)

248 USE OF SCATTERED γ RADIATION IN DEFECTOSCOPY AND MATERIAL THICKNESS MEASUREMENTS. Kodyukov, V. M.; Ostretsov, L. A.; Serebrennikov, I. Ya.; Fradkin, G. M. Defektoskopiya, No. 3, 3-8 (1966). (In Russian).

A method is suggested for separating scattered and non-scattered γ radiation used in defectoscopy and in measuring thicknesses of materials. (R.V.J.)

249 GAMMA DEFECTOSCOPY SPECTROMETRIC METHOD. Kodyukov, V. M.; Ostretsov, L. A.; Serebrennikov, I. Ya.; Fradkin, G. M. Defektoskopiya, No. 3, 9-12 (1966). (In Russian).

A method for using nuclear spectrometry in defect detection, based on the strongest γ quantum and measurements in narrow-beam geometry, is given. (R.V.J.)

247 USE OF FAST NEUTRONS IN DEFECT DETECTION IN MANUFACTURED COMPONENTS. Gorbunov, V. I.

Pekarskii, G. Sh. Defektoskopiya, No. 3, 19-21 (1966). (In Russian).

Defect detection in a 300-mm plastic mass behind a 50- to 100 mm lead shield was achieved using fast neutrons from a Po-Be neutron source. With the signal/noise ratio equal to 2, a 300-mm collimator aperture, and 0.7-MeV detector discrimination threshold the sensitivity for defect detection was 3% of thickness. (R.V.J.)

17801 NONDESTRUCTIVE TESTING OF MACROSCOPIC OBJECTS USING NEUTRONS. Barton, John Penrose (to Univ. of Birmingham). British Patent 1,063,561. Mar. 30, 1967. Filed Jan. 22, 1963.

A nondestructive method including equipment used in obtaining a representation of the interior of a macroscopic body which contains H is described. An incident beam of monochromatic neutrons in the epithermal energy range is directed at the body. The neutrons transmitted by the body comprise unscattered neutrons having an energy level substantially equal to the energy level of the incident beam. The unscattered neutrons are passed to a detector system sensitive to neutrons of the energy range of the incident beam. The equipment used consists of a neutron source, velocity selector, and a detector system. (F.S.)

Tracers

8481 (AEC-tr-6641, pp 170-1) RESEARCH ON THE CIRCULATION IN THE OCEAN BY THE LABELED CLOUD METHOD. Shirel, V. A. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

A method is described for determining the average direction and speed of the transport of water at a given horizon and the turbulent diffusion at depths to 500m. The method utilizes radioisotopes having a short half-life with fairly high energy γ radiation such as ^{84}Rb and ^{86}Rb . The isotopic labeled solution is released from an anchored buoy and detection of the direction of isotope flow is made. (F.S.)

6024 MEASUREMENT OF POLONIUM IN THE RANGE OF 10^{-13} CURIES, TRACING BY ^{208}Po , AND APPLICATION TO THE CHRONOLOGY OF ICE. Crozaz, G.; Fabri, P. (Univ. Libre, Brussels). Earth Planet. Sci. Lett., 1: 446-8 (Nov. 1966). (In French).

A procedure is described for measuring ^{210}Po in the range of 10^{-13} Ci in water and ice samples. ^{208}Po is used as a tracer in order to check the recovery yield. This procedure is of special interest for dating firn cores by the ^{210}Pb method. It is applied now for the measurement of the snow accumulation rate at the Pole of Relative Inaccessibility (82°07'S. 55°06'E). (auth)

10447 RADIOACTIVE TRACING OF STORM RUNOFF ON A SMALL CATCHMENT. I. EXPERIMENTAL TECHNIQUE. Pilgrim, D. H. (Univ. of New South Wales, Kensington). J. Hydrol., 4: 289-305 (1966).

A method was developed whereby radioisotopes were used for direct measurement of travel times of storm runoff on a 96-acre

natural catchment. The primary objective was to measure the time of concentration, but the flow of water from various representative points on the catchment was also traced. The experimental technique and instrumentation are described. Several problems resulted from the impossibility of predicting heavy rain far in advance and from the field conditions prevailing during flood-producing rain. The methods used for overcoming these problems are outlined. Two radioisotopes, ^{198}Au and ^{51}Cr -EDTA, were used. The requirements and types of tracers are discussed, together with safety aspects of the project and the performance of the tracers. The performance of the ^{51}Cr -EDTA was most satisfactory. (BBB)

10446 RADIOACTIVE TRACING OF STORM RUNOFF ON A SMALL CATCHMENT. II. DISCUSSION OF RESULTS. Pilgrim, D. H. (Univ. of New South Wales, Kensington). J. Hydrol., 4: 306-26 (1966).

The use of ^{198}Au and ^{51}Cr for tracing storm runoff on a 96-acre natural catchment is described. Each activity-time record at the catchment outlet provided a hydrograph of outflow of the labeled drop of water. Consideration of these records enabled clarification of the concept of concentration time. Measured values of this time of travel from the point most remote from the catchment outlet were found to depend mainly on the discharge, and also on the duration of rainfall excess. Application of time of travel measurements to a number of hydrograph synthesis methods is discussed. The results also provide information on several aspects of the storm runoff process, including the validity of linear analysis, an apparent partial area runoff production effect, and the distribution of initial loss. (BBB)

16076 COUNT RATE BALANCE METHODS USING RADIOACTIVE TRACERS FOR MEASURING SEDIMENT MASS FLOWS. Courtois, G.; Sauzay, G. (Centre d'Etudes Nucleaires, Saclay, France). Houille Blanche, 21: 279-90 (1966). (In French).

A new radioisotope method is presented for using tracers to study the movement of stream bed sediments. Conventional radioactive tracer equipment is used. Iridium-192 and tantalum-182 were buried in the sediment. By measuring the width of the moving mass and bulk density of the sediment, the velocity of the moving mass could be determined as a function of the detector count rate. The use of several detectors improved the accuracy of the method. Experiments were performed in two rivers in France. The rate of sediment flow during flooding, determined by the tracer method, was estimated to be within 25% of previous estimates. (BBB)

12526 GROUND WATER RECHARGE OF AQUIFERS AS REVEALED BY NATURALLY OCCURRING RADIOCARBON IN VENEZUELA. Tamers, M. A. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Nature, 212: 489-92 (Oct. 29, 1966).

The use of naturally occurring radiocarbon as a means of investigating ground water movement is described. When water enters the ground it carries with it a certain amount of CO_2 . The CO_2 reacts with limestone to form bicarbonate. Limestone, which contains virtually no ^{14}C , dilutes the isotope in dissolved carbonate and so produces apparent radiocarbon ages for ground water which are greater than the actual ages. The method used for the correction of radiocarbon ages consists of the assumption that the amount of limestone dissolved is equivalent to one half of the bicarbonate present and that the carbon from plants and the atmosphere is the equivalent of one half the bicarbonate plus all the dissolved CO_2 . Using the concentrations of these two carbonate species, an estimate of the amount of limestone dissolved is possible. (R.C.K.)

14393 APPLICATION OF ACTIVATION ANALYSIS ON STREAM FLOW MEASUREMENT. Kobayashi, Masatoshi (Japan Atomic Energy Research Inst., Tokyo); Horiguchi, Yasuhiro. Radioisotopes (Tokyo), 15: 317-24 (Nov. 1966).

Tracer experiments to measure the velocity, flow rate and the dilution rate were carried out on the River Kandagawa and the River Nipparagawa. Small quantities of ^{24}Na or ^{82}Br solutions were injected into the rivers as a "pulse" together with rather large quantities of a nonradioactive solution, prior to the continuous injection of a nonradioactive tracer solution. The aim of such a double tracer technique was to compare the advantages and the disadvantages of the radioactive tracer method and the non-radioactive tracer method, and to examine the sorption loss of the tracer by using different elements at the same time. The counting efficiencies of various methods were examined as well as the effectiveness of the total counting method. (NSA of Japan)

16216 RESULTS OF EXPERIMENTAL INVESTIGATIONS OF THE RD-15 INSTRUMENT FOR RADIOACTIVE MEASUREMENTS OF CURRENT VELOCITIES. Dimakysan, A. M. Soviet Hydrol., No. 6, 548-63(1965).

Operational principles of an improved device for radioactive method of measurements of water current velocities are discussed. Results are reported of lab and field tests of the instrument, which was used to measure the speed of snowmelt runoff on slopes and low velocities of flow in open and ice-covered streams, and to measure discharge and movement of water in the ground. Consideration is also given to selection of the radioactive indicator and to its introduction into the medium under investigation. The method is one of introducing a small quantity of radioactive material in liquid form into the medium under investigation. The movement of the radioactive substance with the water of this medium is then determined with the apparatus described. The radioactive indicator may be introduced without producing a radiation level constituting a biologic hazard, since the amount introduced, although adequate for recording, is slight in relation to the total volume of the medium. The RD-15 radiometer, which is described, consists of a recording unit and two sensors. The instrument records γ radiation with an energy of more than 50 keV. The sensors may be submerged to a depth of 3 m or more in water and prolonged operation is possible if the readings are recorded on an automatic recording potentiometer. The circuitry of the RD-15 instrument is shown, as well as ratings of the elements. (BBB)

12699 FLOW RATE MEASUREMENTS IN HYDROPOWER PLANTS BY MEANS OF RADIOISOTOPES. Knapp, M.; Restarovic, S.; Loncaric, J. (Institut za Naftu Zagreb). Int. J. Appl. Radiat. Isotop., 18: 101-9(1967).

Radioisotopes have been utilized to measure flow rates at two large Yugoslav hydroelectric power plants. Measurements taken have provided valuable information about the turbine efficiency and water power value of the plants. The advantages of the method, results obtained and hazards involved are discussed. (auth)

6050 ARTIFICIAL RADIOACTIVITY, OZONE AND VOLCANIC DUST AS ATMOSPHERIC TRACERS IN THE SOUTHERN HEMISPHERE. Dyer, A. J. (CSIRO, Aspendale, Australia). Tellus, 18: 416-20(1966).

The use of artificial radioactivity measurements to study atmospheric transfer processes is particularly attractive in the Southern Hemisphere because of the absence of atomic testing at other than equatorial regions. Observations of volcanic dust at Aspendale (38°S) following the Bali eruption of 1963 show that the bulk of the material arrived in these latitudes after about six months at a height of 20 km. Simple diffusion theory would imply a horizontal transfer coefficient of $4 \times 10^9 \text{ cm}^2 \text{ sec}^{-1}$. A similar value would be inferred from the initial appearance of artificial radioactivity in rainfall following the 1962 series of atomic tests at the equator. However, stratospheric sampling carried out at Mildura (35°S) indicate the poleward transfer of fission products to be rather complex. The first arrival after about six months is well demonstrated at a height of 18 km; but other, stronger centers of activity appeared at 33 km after 6 to 9 months, and at 25 km after 12 months. Seasonal effects are observed in all tracers, but with the various maxima occurring at slightly different times of the year, presumably due to the different heights involved in transfer from an equatorial reservoir. (auth)

5772 ACTIVATION ANALYSIS IN PROCESS CONTROL. Gray, A. L. (Ellhoff Automation Nuclconics, Eng.). Control., 11: 19-23(Jan. 1967).

Activation analysis is discussed as a technique for industrial process control. Like other physical analysis techniques it is restricted to certain elements, but they include many low-atomic-number elements difficult to analyze otherwise. The cost of equipment is high, but the principal applications are to continuous non-destructive testing or analysis of inaccessible materials, and large quantities can be handled, so the capital cost of the equipment is not considered a serious drawback. Activation techniques offer opportunities for completely automatic analysis. (auth)

1300 METHOD OF ACTIVATABLE TRACERS AND ITS RECENT APPLICATIONS TO GLASS MAKING AND PETROLEUM. Bondy, Charles; Vidal, Jean-Pierre; Robin, Gerard. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl., No. 61, 11-15(Sept.-Oct. 1966). (In French).

In cases where the use of radioactive tracers is not suitable, a non-active tracer can be introduced into the system to be studied.

The presence of the tracer is then determined by neutron activation analysis. Some examples are given of neutron activation tracer techniques in glass making and petroleum industries. The general conditions under which this technique is usable are outlined. The examples given include determination of the origin of a motor oil, determination of optimum priming conditions in distillation columns, measurement of displacement time of a distillation unit, and measurement of the residence time of glass in a furnace. The steps in the activation tracer technique are outlined. (J.S.R.)

8233 (IA-1078) LABORATORY APPARATUS FOR THE INVESTIGATION OF SPRAY REACTIONS WITH THE AID OF RADIOACTIVE TRACERS. Foa, E.; Konigsbuch, M.; Lask, S.; Schachter, O.; Stuhl, Z. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Jan. 1966. 9p. Dep. mn.

An apparatus is described, which was built for studying the reactions occurring in a stationary drop. Single droplets of salts labeled with a suitable radioisotope are heated in a current of gas. It is possible to measure the change in the activity of the droplet and/or of the escaping gases, which are absorbed. The apparatus permits the study of the influence on reaction kinetics of temperature; drop size; the flow-rate, composition and humidity of the gases; and the concentration of the solutions. (auth)

4693 USE OF RADIONUCLIDES AND THEIR RADIATION IN PLANT PEST CONTROL. Haisch, A.; Süss, A. (Bayrische Landesanstalt fuer Bodenkultur, Munich). Kerntechnik, 8: 514-17(Nov. 1966). (In German).

The use of labeling techniques to determine the relation between plant, plant pest, and environment to ensure a more effective use of pesticides is discussed. The use of ionizing radiation for killing and sterilizing plant pests is also discussed. Pest sterilization is considered in some detail with the discussion of the modification of the sterilization by endo and exogenic factors, and a review of the results obtained in sterilization studies is given. (J.S.R.)

20029 (STI-PUB-123) RADIOISOTOPES IN THE DETECTION OF PESTICIDE RESIDUES. Panel Proceedings Series. Proceedings of a Panel held in Vienna, 12-15 April 1966. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1966. 120p. (CONF-650457). IAEA: \$2.50; S 65.-; 17/8 stg; F Fr 12,30; DM 10.-.

Topics discussed at the panel meeting were as follows: historical background; use of radioisotopes in the detection of residues in meat and milk; the retention of triphenyltin and dieldrin, and its relevance to the toxic effects of multiple dosing; determination of rogor and cidal by the isotope dilution method; metabolism of triazine and 2,4-D herbicides, and problems with their residues in soils and plants; metabolism of chlorinated insecticides; isolation and identification of metabolites of some chlorinated insecticides and their detection by analytical methods; chemical and physical nature of plant cuticles in relation to the deposition and penetration of pesticides; development of double isotope derivative assays for measurement of pesticide residues; potential of neutron activation analysis of pesticides and metabolites; method of activation analysis for mercury in the biosphere and in foods; labeled reagents and substrates in pesticide analysis; advantages and disadvantages of conventional pesticide determination methods; problems in FAO on human and animal intoxication; problems in WHO on pesticide residues; the joint FAO/WHO program on the toxicity of pesticide residues in food; the development and application of pesticide analysis methods. (H.L.W.)

16077 INVENTORY OF THE QUANTITY OF MERCURY IN AN INDUSTRIAL CHLORINE CELL USING A RADIOACTIVE MERCURY TRACER. Cowley, W. E.; Lott, B.; Brown, S. (Associated Octel Co., Ltd., Ellesmere Port, Eng.). Chem. Eng. (London), No. 204, 345-9(Dec. 1966).

A radioactive-tracer technique is described for the accurate metering of metallic mercury tied up in industrial chlorine-caustic cells. The main advantage of the tracer method is that there is no costly interruption in production during the Hg inventory, as in the alternative method of draining and weighing where all the cells have to be shut down simultaneously. The preparation of a relatively inexpensive mixture of mercury isotopes (^{197}Hg , ^{199}Hg , ^{203}Hg) in a nuclear reactor, for use with this method, is also described. Radiation hazards, associated with this technique, and their prevention, are considered. With the mixture of isotopes used, ^{197}Hg predominates, with a half-life of 65 hr, permitting a Hg inventory to be taken every 6 months. The method consists of

adding a known weight of radiomercury to a cell and allowing sufficient time for it to mix homogeneously with the natural mercury in the cell. A sample of Hg is taken from the dosed cell, its radioactivity counted, and by comparison with the radioactivity of a standard dilution, the original content of Hg in the cell can be computed. The mercury was saturated with the 197 and 197m isotopes (200 mCi/g) and also contained 7.5 mCi/g of the 203 isotope. Prolonged irradiation over one week only slowly increased the concentration of the 203 isotope. In the experiments described 15 mCi was added to each cell which contained about 1500 Kg of mercury to give an activity in the cell of 1 mCi/100 g. In the assessment of health hazards, it is pointed out that the isotope used, mainly ^{197}Hg , has a soft γ -ray emission, but even so it was important to keep the time of handling the silica ampoules to a min. Mercury in air was monitored and, in the initial handling, rubber gloves were worn and film detector badges displayed. (BBB)

175 ISOTOPIC INVESTIGATIONS FOR DETERMINATION OF THE ORIGIN OF ROMAN LEAD TUBES AND LEAD BARS. Groegler, N.; Geiss, J.; Gruenfelder, M.; Houtermans, F. G. (Univ., Bern. Eidgenossische Technische Hochschule, Zurich). *Z. Naturforsch.*, 21a: 1167-72 (July 1966). (In German).

The isotopic composition of lead in archaeological objects can be used to trace the origin of this lead. The lead isotopic composition is given of 10 Roman lead pipes and ingots, found on the European continent. In spite of the limited number of samples and the restricted area, significant differences in the isotopic composition are found exceeding by far the experimental limits of error. Thus, it is shown that the isotopic composition of lead is indeed a sensitive tracer for the origin of historical lead objects. Results are compared with the isotopic compositions of European lead ores. For some examples the possibilities and the limitations of the method are discussed. (auth)

14117 STUDY ON THE APPLICATION OF TRACER SYSTEMS TO LOCALIZE FAILED FUEL ELEMENTS. Henzel, N.; Kadner, M.; Kalix, E. (Battelle-Institutes, Frankfurt am Main). *Atomkernenergie*, 11: 357-66 (1966). (In German).

Conventional methods for locating failed fuel element cans based on the measurement of fission product activities are compared with the radiotracer method. The radiotracer method requires labeling the fuel elements of a reactor with appropriate tracers which are activated within the core by n, γ reaction and which can be identified in the coolant by means of radiation detectors in case of a defective can. Theoretical considerations show that the amount of possible tracer combinations is not sufficient to definitely label the fuel elements of gas-cooled and liquid metal-cooled reactors. Of the 13 tracer compounds appropriate for water-cooled reactors, about seven only can be determined by directly measuring their

activities due to the presence of fission products and contaminants. Thus, in water-cooled reactors labeling can be achieved by using enrichment techniques. As pointed out for two nuclear reactors serving as examples, the neutron economy will not deteriorate essentially by the application of the radiotracer method. (auth)

16055 METHODS OF FLUID MEASUREMENT WITH RADIOACTIVE TRACERS. Hull, D. E. (to California Research Corp.). Canadian Patent 747,483. Nov. 29, 1966.

A small quantity (< one millicurie) of radioactivity miscible or soluble is introduced into a fluid system. Its transit through a predetermined part of the system may be measured accurately and fluid flow calculated. The method is useful for calibrating meters in place and for detecting solid deposits which restrict flow especially in welded piping where access is difficult. A fairly complex detection circuit is required. (F.S.A.)

10425 STUDY ON THE SOLVENT EXTRACTION WITH RADIO-TRACERS. I. EXTRACTION STUDY ON ^{233}Pa WITH THENOYL-TRIFLUOROACETONE. Chen, Ying-mao (National Taiwan Univ., China). *J. Chin. Chem. Soc. (Taiwan)*, 13: 38-47 (Mar. 1966).

^{233}Pa , separated from the irradiated thorium, was used as a tracer for the extraction study with thenoyltrifluoroacetone (TTA). From results obtained by the variation of acidities of HCl with a constant concentration of TTA in benzene, a slope of -2 was obtained by plotting the distribution coefficients against acidities. With a definite acid concentration of H⁺ in the aqueous solution

and by the variation of TTA concentration, a slope of 4 was obtained by plotting the distribution coefficients against the concentration of β -diketone. The species extracted by the organic layer was assumed to be $\text{Pa}(\text{TTA})_2(\text{HTTA})_2$. If the composition of the organic layer was changed by the addition of the following solvents into the TTA in benzene solution, the order of the extraction was found as follows: n-amyl alcohol > cyclohexane > chloroform > n-hexane > carbon tetrachloride > benzene > nitrobenzene > hexane > cyclohexanone > n-butyl alcohol. (auth)

10459 LABORATORY INVESTIGATIONS OF THE DETERMINATION OF THE NONACTIVE CARRIER INFLUENCE ON THE MEASUREMENT OF WATER FILTRATION HORIZONTAL VELOCITY BY MEANS OF RADIOACTIVE ^{131}I . Padzik, Andrzej; Niemczynowicz, Janusz (Przedsiębiorstwo Hydrogeologiczne, Warsaw). *Nukleonika*, 11: 651-8 (1966). (In Polish).

Methods for determining water filtration velocity in the soils are reviewed briefly. The radiometric single-well method of

filtration velocity measuring has been considered in more detail. The nonactive carrier influence on the sorption of tracer in the soil was also examined. Application of this measurement method gives better precision and also facilitates interpretation of the results. (auth)

3331 EVALUATION OF THE CLEANING EFFICIENCY OF SURFACES BY MEANS OF A RADIOACTIVE PENCIL. Yamashita, Yuji (Shimada Physical and Chemical Industrial Co., Ltd., Japan); Sasaki, Tsunetaka. *Denki Tsushin Gakkai Zasshi*, 48: 224-8 (Nov. 1965). (In Japanese).

Removal of contaminations on the surface of metals and solid fabricates is extremely important in painting, galvanizing, and other coatings. In the radioactive tracer technique developed for detection of trace contaminations on such surfaces, some drawbacks in the conventional pencil technique such as insufficient sensitivity and unreliability in the detection are removed. The device consists of a radioactive pencil containing ^{14}C as the lead

of a pencil, and an end-window type G-M counter. The amount of ^{14}C radioactive graphite adhering onto the surface of stainless steel (23 mm in dia, 1 mm in thickness) and the amount removed with a supersonic generator were measured by this device under various conditions of surface roughness and cleaning. The sensitivity attained by this technique under the given conditions showed that it is very useful in inspection and control of clarities. The procedure for preparing the ^{14}C radioactive pencil is also described briefly. (NSA of Japan)

6052 STRATOSPHERIC CIRCULATION STUDIES BASED ON NATURAL AND ARTIFICIAL RADIOACTIVE TRACER ELEMENTS. Bhandari, N.; Lal, D.; Rama (Tata Inst. of Fundamental Research, Bombay). *Tellus*, 18: 391-406 (1966).

The nature of large scale stratospheric circulation was studied using the cosmic ray produced isotopes ^{32}P , ^7Be , ^{35}S , and ^{22}Na as tracers. Supplementary information obtained from observations of the distribution of the bomb-produced ^{22}Na and ^{210}Pb was taken into account. The activities of these tracer elements were measured in the stratospheric air, up to altitudes of 20 km, during 1960 to 1964. Data are fairly extensive for studying the characteristics of the mean circulation in the stratosphere as well as seasonal changes in patterns of mixing/transport of air in certain regions of the stratosphere. (W.D.M.)

1875 STUDIES ON ELECTRODEPOSITION OF TUNGSTEN ALLOYS. V. THE INITIAL STAGE OF ELECTRODEPOSITION OF TUNGSTEN ALLOYS BY USING RADIOISOTOPE ^{185}W . Kudo, Toshiyuki (Osaka Univ.). *J. Metal Finishing Soc. Jap.*, 17: 255-7 (July 1966). (In Japanese).

The determination of trace amounts of W alloys in the initial stage of electrodeposition was studied by using ^{185}W as tracer. ^{185}W was found near the cathode at potentials of 20 ~ 40 mV before the first apparent deposition. When the electrolyte was composed of W salt only, WO_2 was reduced at the cathode and the reduction was promoted by the addition of hydrazine sulfate. The reduction was decreased by the addition of supporting electrolytes such as tartrate and citrate. Accordingly, the supporting electrolytes had no direct effects on the reduction of W ion, but they formed effective complex salts with Fe, Co, Ni, etc. (auth)

4452 INVESTIGATION OF THE HOMOGENEITY OF NEUTRON-ACTIVATED IRON-MANGANESE OXIDE MIXTURES BY MEASURING THE ^{59}Fe GAMMA RADIATION. Roethe, A.;

Roethe, K.-P.; Wagner, K. (Institut fuer Physikalische Chemie, Berlin. VEB Keramische Werke Hermsdorf, Hermsdorf, Ger.). *Isotopenpraxis*, 2: 386-7 (Oct. 1966). (In German).

The ^{59}Fe gamma-radiation of a statistically significant number of neutron-activated iron-manganese oxide samples was measured. For estimating the homogeneity, the standard deviations of the series of measurements were compared with that of the measuring method, and the number of measuring data lying outside the range of the measuring technique has been determined. It was shown that measurements of this kind are suitable for testing sample homogeneity. (auth)

4442 DETERMINATION OF ADSORPTION OF BARIUM IONS ON BARIUM SULFATE BY MEANS OF RADIOACTIVE ISOTOPES. Chursin, V. N.; Babeshkin, A. M.; Zaborenko, K. B. *Radiochim. Acta*, 8: 404-10 (1966). (In Russian).

New methods for determining the adsorption of similar ions on barium sulfate using radioactive isotopes are proposed. The dependence of adsorption size on the concentration of barium ions in the solution was established. It was found that the magnitude of adsorption on surface units depends on the structure and character of the surface of the barium sulfate crystals. Under the conditions studied, the formation of mixed crystals of barium sulfate with barium chloride in the solid solutions does not take place. (tr-auth)

17752 (EUR-3130.f(Vol.3)) ETUDE DU CHARRIAGE D'UN ECOULEMENT PAR TRACEURS RADIOACTIFS. TECHNOLOGIE DES MESURES DE TRANSPORT SOLIDE PAR TRACEURS RADIOACTIFS. (Bed-Material Transport Study by Tracers. Technology of Sediment-Transportation Measurements by Use of Radioactive Tracers). Heuzel, M. (Electricite de France, Paris). Dec. 1966. Contract 019-62-12 IRAF. 34p. (In French). Dep. mn.

Sediment transport was measured using ^{186}Au , ^{192}Ir , and ^{182}Ta as tracers. The sediment included muds, pebbles, and sand. New apparatus tested included an injection device intended for the continuous injection into the mud load of a dredge; a sampler which picks up undisturbed samples of mud or sand from the bottom; and an analyzer. (F.S.)

17589 ISOLATION AND IDENTIFICATION OF ATMOSPHERIC ^7Be . Poetzel, K.; Carnuth, W. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung, Garmisch-Partenkirchen, Ger.). *Radiochim. Acta*, 6: 133-5 (Dec. 1966). (In German).

^7Be can be used as a tracer to measure the intensity of the atmospheric exchange through the troposphere. It is mainly formed just above the latter by cosmic-altitude radiation through interaction with atmospheric nitrogen and oxygen. To allow gamma-spectrometric determination ^7Be must be separated from fallout present in the air. A method of chemical separation, which works quantitatively and was developed especially to that purpose, is described. (auth)

17572 TRACER AND RADIOACTIVATION STUDIES ON TARTAR EMETIC IMPURITIES. Allan, A.; Dessouky, Yehia M.; Shabana, R. (Atomic Energy Establishment, Inshas, Egypt). *J. Pharm. Sci.*, 55: 969-71 (Sept. 1966).

The problem of contamination of tartar emetic with arsenic and lead was examined using the radioisotopes ^{76}As and ^{209}Pb . Antimony potassium tartrate (tartar emetic) is a drug employed in the treatment of bilharziasis, schistosomiasis, leishmaniasis, filariasis, ascariasis, and other tropical parasite diseases. Toxicity after intravenous injection of this drug was reported and attributed to the presence of toxic impurities such as As and Pb. Neutron activation and radiochemical separation methods were developed for the determination of As and Pb concentration throughout the different stages of tartar emetic synthesis. It was shown that, while most of As is eliminated during the synthesis process, the major portion of Pb remains in the final product. It was also found that the 2 impurities can be eliminated by successive washing of the starting materials with 0.2M nitric acid and water. Tartar emetic synthesized from purified starting materials conforms to the requirements in pharmacopoeias. (BBB)

Autoradiography

4458 APPLICATION OF SILVER NITRATE LABELLED WITH ^{110m}Ag FOR AUTORADIOGRAPHIC DETECTION OF FINGERPRINTS. Prokopowicz, Krystyna; Akerman, Karol; Szuchnik, Andrzej (Inst. of Nuclear Research, Warsaw). *Int. J. Appl. Radiat. Isotopes*, 17: 657-61 (Dec. 1966).

Carrier solutions of 0.01N AgNO_3 labeled with ^{110m}Ag having maximal specific activity 2.0-2.5 $\mu\text{C}/\text{ml}$ were used for detecting fingerprints by an autoradiographic method. An empirical equation was derived which gives the exact exposure time of the radioactive specimens on the photographic film to obtain the best autoradiographs. To calculate this exposure time, it is necessary to know the specific activity of the solution used, and to measure the counting rate in cpm of a 0.1 ml portion of the solution used and the investigated specimen under the same geometrical conditions. (auth)

10499 (EUR-3173.e) IMPROVED METHOD OF QUANTITATIVE AUTORADIOGRAPHY FOR INDUSTRIAL PURPOSES. Matteoli, L.; Logi, P. (Istituto di Ricerche Breda S.p.A., Milan (Italy)). Sept. 20, 1966. 64p. Dep. mn.

A simple method to get quantitative measurements from autoradiographs was developed. A method has been set up that requires the exposure at the same time and with the same photographic emulsion of standards of radioactivity and of the sample under examination, tagged with the radioactive tracer. On the autoradiographs obtained, the blackening produced by the beta radiation exposure is measured by a microphotometer. By comparison of the photographic densities of the standard and the sample autoradiographs, taking into account the correction factors, a correlation is calculated, at first between photographic density and radioactivity of the tracer, then between photographic density and the concentration of the tagged constituent in the sample. Series of radioactivity standards have been prepared for ten beta-emitting radioisotopes; the relative photographic efficiency has been determined, so as radioactivity standards of radioisotopes differing from those under examination could be used. Working conditions for reproducible exposures and developments have been determined; several photographic emulsions have been tested. A method to make thin sections of metals and minerals specimens has been developed. Quantitative autoradiography was used in five studies, that are reported as examples of possible applications. They refer to the examination of components liquation in alloys, to the tagging of a mineral, to the absorption on steel surface of a corrosion inhibitor. (auth)

14567 HAIR GROWTH MEASUREMENT USING INTRA-DERMAL ^{35}S CYSTINE. Munro, Dowling D. (St. Mary's Hospital, London). *Arch. Dermatol.*, 93: 119-22 (Jan. 1966).

A new radioisotope method of measuring linear hair growth by the intradermal use of ^{35}S -labeled L-cystine, followed by autoradiography of hairs, was devised and was investigated in experimental animals and humans. It was shown to produce satisfactory results

without danger from radiation as the doses used are very small. In experimental animals, intraperitoneal or intravenous injection of ^{35}S -cystine resulted in detectable radioactivity in the hair follicles within a few minutes, and in the hair shafts several hours later. This incorporation of ^{35}S -labeled cystine may be detected by liquid scintillation counting of dissolved tissue or by autoradiography of the hair shaft or follicle. If two injections are given with an interval between them, the distance between the marks on the autoradiograph will represent the growth of hair in the period between injections. The method is superior to other ways of measuring linear hair growth, owing to its accuracy and cosmetic acceptability in human subjects. It is suitable for marking hairs at intervals during a variety of environmental conditions and drug therapy, while the hairs continue to grow undisturbed. (BBB)

2961 RADIOACTIVE METHOD FOR THE LOCALISATION AND ESTIMATION OF SITOSTEROL ON PAPER CHROMATOGRAMS. Abdel-Wahab, M. F.; Selim, N. L. (MERR Centre for Arab Countries, Cairo). *Z. Anal. Chem.*, 211: 195-201 (1965).

The developed chromatogram is treated with KIO_3 and KI containing ^{131}I , and the presence and amount of the iodinated sitosterols are determined by scanning the chromatogram with a commercial scanner, or by autoradiography. The separation is carried out on paper impregnated with liquid paraffin by development with liquid paraffin-acetic acid-water (1:19:1, w/v/v). (Analytical Abstr.).

10263 UNIT FOR AUTOMATIC COUNTING AND RECORDING OF THE CHROMATOGRAM RADIOACTIVITY. Markelova, V. F.; Tatsievskii, V. A.; Starodub, K. Ya. *Med. Radiol.*, 11: No. 12, 40-2 (Dec. 1966). (In Russian).

An automatic radiometric unit designed for measurement and graphic registration of radioactivity in radiochromatogram patches is described. The unit can be utilized in laboratories where chromatographic (or electrophoretic) fractionation of isotopes or labeled substances is practiced. (auth)

Radiometric Analysis

12346 THE METHOD OF RADIOACTIVE INDICATORS: PRINCIPLE, ADVANTAGES, AND LIMITS. Lerch, P. (Univ., Lausanne, Switzerland). *Chimia (Aaru)*, 21: 1-8 (Jan. 16, 1967). (In French).

The indispensable conditions for the success of the tracer method are discussed; the various ways of labeling are presented and compared. The existence of isotopic effects constitutes a fundamental limitation of the radioactive tracer method, which may be capable of compromising its results. The physical isotopic effects are first explained; the different categories of chemical isotopic effects are then described; and their incidence in radiochemistry is examined. The radiolytic action of radiation emitted by the radiotracers represents a second fundamental limitation to be considered by the radiochemist; the chemical transformations of the labeled molecules, which occur at the very moment of disintegration, constitute a third, not always negligible limitation; these phenomena are described and their importance evaluated. Several experimental contingencies may also play a part in limiting the use of the radioactive tracer method; it is often essential to have available radioisotopes of high specific activity; the radioisotopic, radiochemical, and chemical purity of the radioactive substances exercise an important influence. The choice of radioisotope (half-life, nature and energy of the radiation emitted), when this is possible, can have a decisive influence on the success of the tracer method. Finally, the problem of radiation protection of the operators and the imperatives prescribed by it is touched on. (auth)

2966 RADIOMETRIC DETERMINATION OF SILVER. Smit, J. van R. (CSIR, Pretoria). *Analyst*, 90: 366-7 (1965).

In work by Pierce on equilibration of a solution of the oxodithizonate of radioactive Ag in an organic solvent with an aqueous solution containing an unknown amount of inactive Ag, it was known that if conditions are such that the amount of Ag passing from the organic to the inorganic phase during equilibration is negligibly small, and if S_i (moles of Ag originally in the aq. phase) is much less than S_o (moles originally in the organic phase), the counting rate at equilibrium should be proportional to the specific activity of the radioactive Ag taken. Pierce confirmed this by an experimental calibration graph for amounts of Ag from 0 to 12 μ g, which was rectilinear from 0 to 1 μ g of Ag, although subsequently curved. It is now shown that by plotting the results in a different form, expressing the amounts of Ag as mass units instead of as equivalents and re-arranging the original equation without the assumption that S_i is much less than S_o , and with the terms expressed as their reciprocals, a wholly rectilinear graph is obtained. (Analytical Abstr.)

2987 ANALYSIS WITH THE AID OF RADIOACTIVE REAGENTS. Lerch, P. (Institut de Radiophysique Appliquee, Lausanne, Switzerland). *Microtecnic*, 20: 414-15 (Aug. 1966).

The definition and principle of the technique of using a radioactive reagent in a chemical reaction that results in a change in phase of the reactants are outlined. This change of phase can be release of gas, solubilization of a fine suspension by complexation, or precipitation. As an alternate to adding the radioactive reagent in excess and measuring the amount present in a product or in measuring the excess, the radioactive reagent can be added by means of a titration method. This method of titration is applicable to a titration reaction that forms a precipitate as well as to one in which either the solvent or a reaction product must be removed by solvent extraction. All the experimental techniques as well as a titration arrangement are described in detail. (B.L.M.)

14166 ANALYSIS WITH THE AID OF RADIOACTIVE REAGENTS. II. Lerch, P. (Institut de Radiophysique Appliquee, Lausanne, Switzerland). *Microtecnic*, 20: 633-5 (Dec. 1966).

The use of radioactive reagents in chemical analysis is reviewed. Applications included are the determination of SO_4^{2-} ions using radioleads; determination of CrO_4^{2-} , VO_3^- , and MoO_4^{2-} ions using ^{110}Ag ; determination of Mg^{2+} using ^{32}P ; radiometric titration of iodides using ^{131}I ; complexometric titration of the amino acids that complex copper using ^{64}Cu -labeled copper phosphate; and determination of oxygen dissolved in water using dissolution of a labeled metal. Titrating procedures using radioactive reagents; radiocoulometric analyses, radioactive precipitates on membranes, and radiolabeled amalgams are discussed. (D.H.M.)

15852 NEUTRON ABSORPTIOMETRIC TITRATION. Toelgyessy, J.; Varga, S.; Dillinger, P. (Slovak Technical Univ., Bratislava). *Talanta*, 14: 441-2 (Mar. 1967).

A method is outlined for detection of two-phase titration endpoints by means of an abrupt change in the neutron-absorption characteristics of one of the phases. One of the components of the precipitate must have a large neutron absorption cross-section, and the disappearance or appearance of neutron absorption by the supernatant liquid from the precipitation reaction then marks completion of precipitation. (auth)

19567 RADIOGRAVIMETRIC DETERMINATION OF POTASSIUM. I. DETERMINATION OF POTASSIUM IN MINERALS. Rodziewicz, Włodzimierz; Grzedzicki, Kazimierz (Politechnika, Danzig). *Chem. Anal. (Warsaw)*, 12: 49-56 (1967). (In Polish).

The determination of potassium using results from the gravimetric determination of quantitatively precipitated potassium-sodium cobaltinitrite and determination of the potassium content from the β radioactivity of a sample of the $\text{Me}_3[\text{Co}(\text{NO}_2)_6]$ precipitate ($\text{Me} = \text{K} + \text{Na}$) is described. The measurements of radioactivity were carried out with a G-M tube and the samples were prepared as "infinitely thick" or as 0.122 g/cm² thick. The potassium content in $\text{Me}_3[\text{Co}(\text{NO}_2)_6]$ was found from calibration curves set up for the layer thicknesses of 0.407 g/cm² and 0.122 g/cm². Absolute error of the results obtained by the radiogravimetric method was 0.02 to 0.2%. The results obtained show that sufficient accuracy can be achieved by preparation of samples thinner than the "infinitely thick." (auth)

8207 DETERMINATION OF THE RARE-EARTH ELEMENTS OF THE CERIUM GROUP BY RADIOMETRIC TITRATION WITH 8-HYDROXYQUINOLINE. Maryanov, B. M.; Serebrennikov, V. V. *Tr. Tomsk. Gos. Univ., Ser. Khim.*, 157: 8-11 (1963). (In Russian).

It was found that Ce^{3+} and Nd^{3+} can be titrated radiometrically with 8-hydroxyquinoline in solution of pure salts, with ^{147}Pm as radioactive indicator. The titration is carried out in ammoniacal buffer solution at pH 9 in the presence of tartrate to prevent the precipitation of hydroxides. In the titration of Ce, hydroxylammonium chloride is added to the solution to prevent oxidation of Ce^{3+} to Ce^{4+} . Titration with 8-hydroxyquinoline was used to determine considerably smaller amounts of the rare earth elements than does radiometric titration with oxalic acid and the long delay to ensure complete precipitation was avoided. The error of determination is $\pm 5\%$. Results for the titration of elements of the Y group were unsatisfactory, apparently because of the precipitation of double tartrates. (Analytical Abstr.)

1263 MICRODETERMINATION OF IODIDE IONS BY RADIOACTIVE PRECIPITATION EXCHANGE. Banyai, E.; Szabadvary, F. (Technische Univ., Budapest). *Mikrochim. Acta*, No. 4-5, 601-5 (1966). (In German).

If iodide ions are shaken with a HgI_2 precipitate, soluble iodo-mercurate results. The activity of the solution is proportional, within certain concentration limits, to the amount of iodide. (auth)

12348 ANALYSIS WITH RADIOACTIVE REAGENTS AND RADIOMETRIC TITRATION. Braun, T. (Univ. L. Eotvoes, Budapest). *Chimia (Aaru)*, 21: 16-26 (Jan. 16, 1967). (In German).

Examples are given in the fields of radioreagent methods based on solid-liquid, gas-liquid, and liquid-liquid phase separation. The possibilities for a radiometric end-point detection are discussed. Titrations based on precipitation formation with solid-liquid separation as well as titrations based on complex formation with liquid-liquid separation are mentioned. Radiometric titrations using solid indicators, radioactive amalgams, and radioactive metals are discussed. (D.H.M.)

5814 DETERMINATION OF THE EQUIVALENCE POINTS AND SOLUBILITY PRODUCTS IN RADIOMETRIC AND SIMILAR PRECIPITATION TITRATION. Kias, J. (Slowakische Technische Hochschule, Bratislava). Collect. Czech. Chem. Commun., 31: 3512-18 (Sept. 1966). (In German).

A method for the equivalence point determination in precipitation titrations is proposed. The method has no errors caused by the solubility of the precipitate so that it can be used in titrations of very dilute solutions. The equivalence point can be calculated from two points of the linearized titration curve and these data can be used for determining the solubility products of the precipitates. The method can be used in radiometric and similar titrations, when the reaction proceeds according to the equation $A + B = AB$ and when the ion to be titrated is active. (tr-auth)

5815 SYSTEMATIC ERRORS IN RADIOMETRIC AND SIMILAR PRECIPITATION TITRATIONS. Kias, J. (Slowakische Technische Hochschule, Bratislava). Collect. Czech. Chem. Commun., 31: 3519-28 (Sept. 1966). (In German).

The systematic errors arising in the titration of radiometric and similar precipitation titrations because of precipitate solubility and dilution of the solution to be titrated with the titrating medium were investigated. The equation for the errors of some currently used methods for determining the titrant were derived when the precipitation proceeds according to the equation $A + B = AB$ and when the ion to be titrated is active. Tables of the calculated errors are given as examples for application of the equations derived. (tr-auth)

5771 CONTRIBUTION TO THE DETERMINATION OF THE EQUIVALENCE POINT AND OF THE SOLUBILITY PRODUCT IN RADIOMETRIC AND SIMILAR PRECIPITATION TITRATIONS. Kias, Jan (Katedra Anorganické Chemie, Bratislava). Chem. Zvesti, 20: 523-9 (1966). (In Czech).

The theory of precipitation titrations from the viewpoint of direct equivalence point determination in dilute solution and that of determination of solubility products under the same conditions is examined. An equation is devised with a coordinate system such

that the titration curve is described by a straight line whose slope gives the equivalence point and whose x-intercept determines the solubility product for an insoluble compound A_mB_n . These expressions may be used for titration of either A or B. Determination of the solubility product is not necessary for evaluation of the equivalence point for a very dilute solution. The equivalent consumption of titrant is determined from experimental variables, and the solubility product may be determined from the same data. The rules will be verified by experimental application to $TlBr$. (BBB)

19550 DETERMINATION OF IRON BY CHELATING RADIO-METRIC TITRATION. Konecny, J.; Toelgyessy, J.; Braun, T. (Slovak Technical Univ., Bratislava. Eotvos Univ., Budapest). Acta Chim. Acad. Sci. Hung., 51: 245-9 (1967).

In an investigation of a chelating radiometric titration, 5×10^{-3} M EDTA solution, Dowex 50 W-X2 cation exchanger, and $^{55+59}Fe$ radionuclide were used as the titrant, for the separation of components, and as the indicator, respectively. Iron in pharmaceutical products (Tinctura Ferri aromatica) was determined. The method can also be used to determine amounts of submicro grams of iron. (auth)

19559 APPARATUS FOR AUTOMATIC EXTRACTIVE RADIO-METRIC TITRATION. Kukula, F. Isotopenpraxis, 3: 17-19 (Jan. 1967). (In Russian).

The apparatus described for continual extractive radiometric titration enables automatic time- and volume-controlled dosage of complexing reagents into the analyzed solution and its stirring. The activity of either the organic or inorganic layer can be measured and recorded by means of a pen recorder. The apparatus can also be used for studying extraction processes and their kinetics, for complexometric and similar studies, when the appropriate device (pH meter, recording colorimeter etc.) is attached. The use of this apparatus for isotopic dilution analysis and for studying substoichiometric methods of separation of some elements in activation analysis serves as an example of its application. (auth)

COMMERCIAL PRODUCTS PRESERVATION

Medical Supplies

9043 APPLICATIONS OF INTENSE RADIATION SOURCES TO FOODS AND BIOSYNTHETIC DRUGS. Mouton, Robert (Univ. Libre, Brussels). pp 173-207 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The applications of high radiation sources to foods and biosynthetic drugs are considered. Justification of these applications of nuclear energy, their potentials, and their application limits were examined. The evolution of national and international research programs is outlined. Some fundamental concepts that can be used to guide present and future programs are given. (J.S.R.)

20456 (RISO-140) THE BASIS OF THE DANISH CHOICE OF DOSE FOR RADIATION STERILIZATION OF DISPOSABLE EQUIPMENT. Christensen, Ebbe Ahrensburg (Statens Serum-institut, Copenhagen (Denmark)); Holm, Niels W.; Juul, Flemming (Danish Atomic Energy Commission, Risoe, Research Establishment). Sept. 1966. 18p. Dep. mn.

This report describes the basis of radiation sterilization of medical utensils in Denmark and of the choice of dose for sterilization at Risø of disposable equipment of dry plastic. The possibilities of establishing general criteria for efficient sterilization by comparison with autoclaving are dealt with. A description is given of the selection of test strains and test pieces for use in fixing the dose for sterilization of a particular category of utensils and in controlling the microbiological effect of the irradiation. The possibilities of continuous control of disposable equipment based on counting of the micro-organisms present on the equipment prior to irradiation are discussed. Such day-to-day control must be assumed to warrant a reduction of the routine dose below the minimum of 4.5 Mrad used in Denmark for dry plastic equipment. (auth)

Food

11164 IONIZING RAYS PROLONG THE USEFULNESS OF FOODSTUFF. Fleischermeister, No. 2, 47 (1966). (In German).

The usefulness of foodstuff can be prolonged with small doses of rays, primarily gamma rays which induce little or no radioactivity. The radiation is applied to the surface or beyond the surface, depending on the type of foodstuff. The preservative effect sets in

without a rise in temperature so that the foodstuff freshness is retained. The ionizing rays kill microbes, molds and insects, prevent the germination of potatoes, affect the ripening process of fruit, preserve mushrooms, bacon, French fries and fresh fish, and control salmonella infections in eggs, meat, and fish. The small doses of radiation used in the sterilization and pasteurization of foodstuff have not produced any toxic or cancer-inducing substances and there is no evidence that the irradiation has an unfavorable effect on the foodstuff. The nutritive value of foodstuff is only slightly affected by the irradiation (destruction of vitamins K and E) while its other qualities are the same as in heat-treated foods. (JPRS)

16554 IMPORTANCE OF BACTERIAL SPORES TO THE FOOD INDUSTRY AND POSSIBILITIES FOR DECREASING THEIR RESISTANCE. Farkas, Jozsef (Koezponti Elelmiszeripari Kutatóintézet, Budapest). Elelm. Ipar, 19: 48-56 (Feb. 1965). (In Hungarian).

An extensive description is given of the heat and radiation resistance of spores of various bacteria, composition and structure of spores, mechanisms of spore resistance, mode of germination of spores, and the possibilities of reducing spore resistance. In experiments which were conducted on *Bacillus cereus*, germination occurred in nearly 100% of spores after heat treatment and application of germinating stimuli. The spores subjected to 200 Krad irradiation showed a 50-fold decrease in survival rate. A

one-hr suspension in a solution containing 0.4 mg/ml adenosine and 0.4 mg/ml alanine further reduced the survival rate from about 40% to 0.05%. It was found that ionizing irradiation made the spores in food products more susceptible to destruction by heat and made storage of the product at room temperature for prolonged periods possible. (BBB)

14779 MODERN METHODS OF FOOD PRESERVATION. Bosund, Ingmar (Nordreco AB, Bjuv, Sweden). Svensk Kem. Tidskr., 78: 413-31(1966). (In Swedish).

Advances in the use of ionizing radiation for food pasteurization and sterilization are reviewed, along with other new processes for preservation of foodstuffs. Processes employing ^{60}Co or ^{137}Cs sources were studied to the greatest extent, but electron accelerators were also used for high-energy irradiation of some products. Side-effects produced when high sterilizing radiation doses are used are discussed, and bacon is cited as an example of successful use of this procedure. Pasteurization doses are better tolerated, with less objectionable changes in color, flavor, and texture. Use of heat combined with radiation to eliminate some of the most radioresistant microorganisms is discussed. Use of radiation for eliminating pests from stored products and to reduce sprouting of some vegetables, such as potatoes, is also considered. Doses employed in these applications generally do not impart objectionable qualities in the product. Status of radiopasteurization research in various countries is briefly mentioned. (BBB)

6743 USE OF IONIZING RADIATION IN FOOD PRESERVATION. Ley, F. J. (Wantage Research Lab., Eng.). Chem. Ind. (London), No. 27, 1183-4(July 2, 1966).

A report is given of the use of ^{60}Co γ radiation and fast electrons for food sterilization and pasteurization. Apart from economic considerations the choice of source largely depends on the degree of penetration required. Gamma rays may be used for the treatment of food with a target depth up to about 30 cm whereas with electrons, the depth is restricted to several centimeters. However, electrons can be produced with extremely low penetrating power for treatment of surfaces only. Potential applications of radiation in food preservation were classified in relation to the total dose required to produce the desired effect. The max dose proposed is 4.8 Mrad with reference to the sterilization of non-acid foods, in particular fresh meat and fish. The dose is calculated to eliminate *Clostridium botulinum* type A spores, since room temperature storage is used after irradiation. Such high dose treatment has met with limited success since unacceptable odor and flavor changes have been apparent, and such treatment does not completely inactivate enzyme activity so that quality loss occurs during storage. Research in the United Kingdom has been concentrated mainly on processes involving doses of 0.1 to 0.5 Mrad, which is much lower than that recommended for sterilization, and detrimental effects on quality are largely avoided. The aim is to increase the refrigerated storage life (0° - 5°C) of commodities such as fish, poultry, and meats. The use of radiation to eliminate *Salmonella* from certain foods is discussed. Gamma radiation may be ideal for the treatment of frozen horse-meat imported as pet food in large frozen blocks. It could be treated with a radiation plant ideally situated near the dockside. The meat would remain frozen and packed in its original container during treatment. Entomological research has demonstrated the effectiveness of a dose of about 20,000 rad for the disinfestation of stored grain. The question of the wholesomeness of irradiated food is also considered briefly. (BBB)

446 PRESENT STATUS OF FOOD IRRADIATION. Goresline, H. E. (International Atomic Energy Agency, Vienna). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-75/29, 10p. (CONF-660711-6). ORAU.

From Seminar on the Use of Radioisotopes and Radiation in Dairy Science and Technology, Vienna.

The status of the food irradiation program is reviewed, including radurization, radication, and radappertization.

Results of radurization treatments of fruit, vegetables, fish, and meat and poultry are reviewed. Radication in meat and poultry, fish and seafood, eggs, and miscellaneous items is summarized. Radappertization has been the most popular of the processes because of the potential for producing foods that more closely resemble items as prepared for table than do most heat-processed products. It is pointed out that the safe treatment for food of pH 4.5 and

above must be designed specifically to kill *Clostridium botulinum* spores. So far, irradiation of non-acid vegetables has not been satisfactory due to the softening of texture caused by the combined heat and irradiation treatment, and no class of dairy foods can be successfully irradiated. However, radiopreservation of a number of stable fish items has been reported. (H.G.D.)

4894 STERILIZATION AND PASTEURIZATION BY HIGH-ENERGY RADIATION. Diehl, J. F. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Kerntechnik, 8: 506-10(Nov. 1966). (In German).

The development of sterilization and pasteurization by high energy radiation is reviewed. Possible areas of application and the radiation doses required are discussed and tabulated. The safety of irradiated food is emphasized. The legal situation with respect to the sale of irradiated food is briefly discussed. (J.S.R.)

12557 FOOD PRESERVATION BY IRRADIATION IN THE WORLD. Comit. Naz. Energ. Nucl., Notiz., 12: No. 8-9, 69-81(Aug.-Sept. 1966). (In Italian).

Current activities in the investigation of food preservation by irradiation in the major countries of world are reviewed. Radioisotopic sources and other equipment, including mobile irradiation units are described. Results of research on fruits, vegetables, fish and meats are summarized. (F.S.)

9045 THERMO AND RADIOSENSITIVITY OF VITAMINS. Causeret, Jean; Mocquot, Germain (CNRS, Jouy-en-Josas, France). pp 149 64 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

From the monograph on the thermo- and radiosensitivity of vitamins, the section on conservation of food materials by ionizing radiation is presented. The technological and nutritional aspects of the radiation preservation of milk and milk products, meat, eggs, potatoes, fish, and cereals are considered. (J.S.R.)

9044 INDUSTRIAL IRRADIATION: APPLICATION TO THE TREATMENT OF AGRICULTURAL AND FOOD PRODUCTS. Pierlas, R.; Rondenay, F. (Societe Saint-Gobain Nucleaire, Courbevoie, France). pp 5-17 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The Cs irradiation facility at Saint-Gobain Nucleaire is described. The radiation facility is mobile and is designed to study exploitation costs and applications. The capital costs for an industrial irradiation facility are briefly considered. (J.S.R.)

16539 EXPERIMENTAL CONTRIBUTION TO THE QUESTION OF STERILIZATION WITH ^{60}Co . Schabinski, G. (Friedrich-Schiller-Univ., Jena, Ger.). Deut. Gesundheitsw., 14: 859-61 (1959).

Studies of effects of ^{60}Co irradiation of gram-positive and gram-negative organisms showed that gram-negative bacilli were sensitive to γ radiation at 30,000 to 50,000 rep; gram-positive bacilli and cocci were sensitive at 60,000 to 100,000 rep; and spore formers were sensitive to 1.5 to 2 M rep. *Candida albicans* and *Saccharomyces cerevisiae* were sensitive to 30,000 to 40,000 rep. Irradiation tolerance of *Escherichia coli* was observed to increase as the dose was gradually increased from 30,000 to 70,000 rep. Cells became increasingly pleomorphic but retained staining characteristics. The possibility that this resistance to irradiation may be due to formation of superoxides was studied. Radioresistance was observed to be parallel to insensitivity to H_2O_2 concentrations. Effects of temperature on radiosensitivity were measured by exposure of cells to irradiation at -10 , $+4$, and $+20^\circ\text{C}$. The greatest radiosensitivity of cells was found at 20°C within a range of 33,000 rep. On the basis of these results, it appeared that at doses lower than sterilization doses there were fewer side-effects and that an increase in induction of radioresistance may have occurred. (BBB)

Wholesomeness

14786 CONCERNING THE POSSIBLE DANGERS FOR THE CONSUMER CAUSED BY CONSERVATION OF FOODS BY IR-

RADIATION. Tuchscheerer, Th.; Peter, G. (Bundesforschungsanstalt fuer Lebensmittelrischhaltung, Karlsruhe, Ger.). *Atompraxis*, 12: 573-6 (Nov. 1966). (In German).

In comparison with the maximum permissible concentration, the possible danger of irradiated food for the consumer is estimated. The particular significance of long-lived radioisotopes originated by preservation of food by irradiation is pointed out. If the products are irradiated with 20 MeV radiation energy, and under the condition that only irradiated products are consumed, the necessary storage time is 4 to 5 days. The possibilities for reducing storage times are discussed. (auth)

1854 STERILIZING WITH IONIZING RADIATION. Clouston, J. G.; Sangster, D. F. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). *Austral. J. Pharm.*, 45: Suppl. 18, 548-51 (June 30, 1964).

Use of radiation to sterilize food and medical supplies is reviewed, with emphasis on the doses required, chemical effects, and technology of the process. If radiation processing of food must be equal in public health safety to thermal processing and for those foods where *Clostridium botulinum* is a hazard, an inactivation factor of 10^{12} would be necessary. However, in the sterilization of medical equipment by ionizing radiation, a standard inactivation factor may not exist but from a study of the degree of sterility achieved by thermal methods a factor of 10^7 might be necessary for a radiation-resistant standard organism. Examples are cited to indicate that this standard is being met, when radiation is being used for medical sterilization. Some considerations in determining the best conditions for killing organisms are temperature, moisture, spore or vegetative form, and the presence of protective or sensitizing agents, in particular oxygen. Doses in the range 2.5 to 4.5 Mrad seem to give adequate security. Although the chemical and physical changes produced in irradiated materials are, for many applications negligible, they may affect the biological activity of medicinal chemicals. This aspect is discussed. Substances in solution, particularly aqueous solution, are generally more susceptible to chemical change than dry substances. Not enough is known about the effects of radiation on organic substances in general to predict the effects in a particular case and so each compound or preparation has to be examined empirically. It is concluded that industrial processing with radiation is at present limited, but it may be more widely used in the future for the sterilization of pharmaceutical preparations. (TCO)

6742 WHOLESOMENESS OF γ -IRRADIATED POTATOES. II. FEEDING EXPERIMENTS WITH PIGS. Jaarma, Maire; Bengtsson, Goesta (Royal Univ., Stockholm). *Nutr. Dieta*, 8: 109-29 (1966).

Previous work indicated that no obvious unfavorable effects could be observed in pigs and rats fed irradiated potatoes. The investigation was repeated with larger groups of animals to ascertain whether the feeding of γ -irradiated potatoes to pigs could cause any toxic effects. Whether this diet, given for a longer period to pigs in two generations, has had any influence on the fertility or on the bacon quality of the animals, was also examined. Three common Swedish varieties of white potato, Bintje, King Edward, and Magnum Bonum, were used in equal quantities. The main part of the tubers was irradiated in a ^{60}Co source at a dose rate of 150 R/sec. A smaller portion was irradiated at the lower dose rate, 620 R/hr in a ^{137}Cs source. The dose in all experiments was 14 to 15 krad. Irradiated and nonirradiated control potatoes were fed to fattening and breeding pigs (Swedish Land Race), a total of 116 pigs in two generations. Potato feeding was introduced when the pigs had reached a weight of 25 kg, the ration of potatoes being gradually increased from 0.5 to 4 kg per pig per day. Each fattening pig received about 200 kg potatoes, each sow in the breeding series a total of 900 kg potatoes up to the end of the lactation, and each boar 600 to 700 kg. The general health, growth, and fertility of the animals were observed. During the feeding period samples of blood were taken regularly. The test included red and white blood cell counts, determination of the hemoglobin concen-

tration, and of the activities of the enzymes ornithine-carbamoyl-transferase (OCT), aspartate-aminotransferase (GOT), and alanine-aminotransferase (GPT) in plasma. After slaughtering, some organs were examined histologically. No divergence from the control animals could be observed. Quality tests of the meat products did not give any significant differences between the groups, nor could any other detrimental effects be found in the pigs fed the irradiated potatoes. A tendency towards faster growth in the pigs fed irradiated potatoes was noted. In many of these animals, a faster increase in the hemoglobin level and a high hemoglobin concentration were also observed at the end of the experiment. Determinations of enzyme activities as well as blood cell counts gave the same results for both groups. The fertility and the number of pigs in each litter were also equal. Furthermore, the second-generation pigs provided no indication that irradiated potatoes might give rise to deleterious effects. (BBB)

16557 ON THE WHOLESOMENESS OF γ -IRRADIATED POTATOES. Jaarma, Maire; Henricson, Bengt (Royal Univ., Stockholm). *Acta Vet. Scand.*, 5: 238-56 (1964).

Potatoes of the Swedish variety Vlt Drottning (Eldorado), γ irradiated with germination-inhibiting doses by ^{60}Co (14-16 krad at 175 R/sec) or ^{137}Cs (14-15 krad at 625 R/hr), were fed for 4 months to fattening pigs and pigs for breeding. Wistar rats were also fed irradiated potatoes, but in this case the tubers were given a dose of about 200 krad. No unfavorable effects were observed from the feeding of irradiated potatoes. All the data indicated that the nutritional adequacy of the irradiated and the control tubers was equal. In some cases, the animals even showed an improvement after feeding on irradiated potatoes which was not apparent after feeding on nonirradiated potatoes; for example, there was more rapid growth, higher fertility, and increased hemoglobin values. If the irradiated potatoes actually have properties which stimulate growth, this might be due to the more easily digested carbohydrates which are produced by irradiation. Chemical analysis of carbohydrates in irradiated potatoes provides evidence that this may be true. There was some evidence, although not significant, indicating that the iron content of the liver was lower in animals fed irradiated potatoes. (BBB)

9039 TOXIC EFFECTS OF IRRADIATED FOODS. Loeftroth, G. (Univ., Stockholm). *Nature*, 211: 302 (July 16, 1966).

Hazards from radioinduced toxins in foods irradiated for the purpose of extending shelf life are considered. Since no evidence exists for the cellular specificity of activity for any class of compounds producing cytogenetic or cytotoxic changes, it is suggested that plant cells and cell cultures may be used in preliminary evaluation of irradiated foods. Such preliminary tests would be followed by tests in animals. (H.G.D.)

9046 FOOD HYGIENE AND IONIZING RADIATIONS.

Morre, J. (Laboratoire de Radiobiologie du Service Veterinaire de la Seine, Paris). pp 101-22 of *Applications des Rayonnements en France*. Vol. II. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Nuclear energy affects food hygiene in two very different ways: active fallout contaminates the soil, plants, and animals but ionizing radiation can preserve food. Each of these two aspects are discussed. In the contamination of food the contamination is evaluated generally by a determination of either the total radioactivity or a determination of the concentration of ^{90}Sr and ^{137}Cs . The techniques used for food preservation are briefly outlined. The principle food elements exposed to ionizing radiation for preservation are reviewed. These include, fruits, potatoes, seafood, meats, and eggs. (J.S.R.)

9047 BIOSTIMULATIVE EFFECT OF IRRADIATED CHRYSALIS MEAL ON PIGLET DEVELOPMENT. Gavrila, V.; Jurubescu, V.; Alexe, Gh.; Holerca, J. *Lucrari Stiint.*, Ser. C, VII, 451-4 (1964). (In Rumanian).

Feed supplemented with an irradiated industrial meal including silk-worm pupae administered to piglets in progressive doses (starting with 0.50 cg/kg bodyweight) stimulated their growth and development rate. The supplement administered to a first lot resulted in a 6 kg gain, on the average, while the average daily gain in the second lot was of 60 to 70 g, as against the controls. The treatment was more efficient during winter than in summer. The 10-months observation period showed that the gilts of the first lot had 9 to 14-strong litters (as compared with the 6 to 9-strong litters of the controls) and that newly born piglets registered higher birth weights. (auth)

20459 NINETY DAY RAT FEEDING STUDY ON IRRADIATED STRAWBERRIES. Verschuuren, H. G. (National Inst. of Public Health, Utrecht); Van Esch, G. J.; Van Kooy, J. G. Food Irradiat., 7: No. 1-2, A17-A21 (July-Dec. 1967).

Over a period of 12 weeks Wistar rats received strawberries that were nonirradiated or irradiated with 500 and 5,000 krad respectively. In one experiment the strawberries were given as a 5% strawberry-powder in the diet; in the other experiment as "strawberry-juice" by stomach tube. The male rats which received strawberry-powder irradiated with 5,000 krad showed a statistically significant growth retardation. There appears to be no reasonable explanation for this abnormality. The corresponding female rats receiving the same powder and rats of both sexes receiving the juice irradiated with 5,000 krad showed no significant effects. No obvious influence on the blood composition could be discovered in the different groups. Histopathological investigation of the organs did not show abnormalities which could be connected with the administration of the irradiated strawberries. It has been clearly demonstrated that the animals, which received strawberries irradiated with 500 krad, did not show any kind of toxic effects. These results show that the preservation of strawberries by irradiation is biologically acceptable and seems therefore to be promising. It might, however, still be necessary to carry out chronic toxicity experiments. The next step to be investigated before commercialization is whether this process is

economically viable. Data on the economics will become available from pilot plant work in the Netherlands during 1968. (auth)

Grain

6672 INFLUENCE OF THE GAMMA IRRADIATION DOSE RATE ON THE LIFETIME OF GRANARY WEEVILS. Zakladnoi, G. A. (All-Union Scientific Research Inst. of Grain and Products of Its Processing, Moscow). Radiobiologiya, 6: 478-9 (1966). (In Russian).

Increasing the dose rate accelerates the death of granary weevils. With increasing irradiation dose from 12 to 50 krad, the difference in the effect of the dose rate is leveled out at the level of 99.9% death of the weevils; however, the total effectiveness is negligibly reduced. (auth)

9042 CAN NUCLEAR ENERGY BE USED FOR THE PROTECTION OF CEREAL STORES AGAINST INSECTS? Pesson, P. Inform. Doc. Agr., No. 2, 1-12 (Jan. 15, 1965). (In French).

Efforts to destroy the cattle fly in Florida using radiation sources are reviewed. The conditions under which sterilization of the male can be applicable to insect pests in cereal stores are defined. Hazards from the use of radiation are summarized. (J.S.R.)

Root Crops

16556 ON THE WHOLESOMENESS OF γ -IRRADIATED POTATOES. III. FEEDING EXPERIMENTS WITH RATS. Jaarma, M.; Henricson, B.; Bengtsson, G. (Royal Univ., Stockholm). Nutr. Dieta, 8: 296-308 (1966).

Wistar rats were fed γ -irradiated potatoes of the variety Vit Drottning (Eldorado). In all experiments the dose was about 200 krad and the potatoes were given raw, with one exception, in which the dose was 14-15 krad and the potatoes were fed steamed. No deleterious effects have been found in rats given maximal amounts of irradiated potatoes. Nor have significant differences been observed between irradiated- and control-potato groups when the feeding period extended over 65 weeks. The experimental diet caused no negative effects, as reflected by general health, growth, and hematological findings in the offspring of the second and third generations. A numerically, but not significantly, higher growth rate in favor of the groups fed irradiated potatoes was observed in some experiments. The same tendency was also present in the second generation (the mother fed irradiated potatoes) and in the third generation (the maternal grandmother and both parents fed irradiated potatoes). The difference in the third generation was 8% in the males. Irradiation of potato tubers raised the sucrose content, calculated to be 1% of the amount of food used. To study the possible effect on weight gain of the increased proportion of sucrose, 1% of sucrose was added to the diet of one group of control animals. This addition significantly increased the growth rate of the control females and almost eliminated the difference between irradiated and control groups. (BBB)

9037 SOME EFFECTS OF GAMMA RADIATION ON SEVERAL VARIETIES OF TASMANIAN POTATOES. I. STORAGE PROBLEMS. Wills, Pamela A. Austral. J. Exper. Agr. Animal Husbandry, 5: 282-8 (1965).

The effects of doses of 5,000 and 10,000 rads of γ radiation and subsequent storage at 68°F and 45°F on sprouting of several varieties of potatoes were investigated. The majority of the irradiated tubers were commercially sound after 6 mo storage. Tubers stored at 45°F were in better condition than those stored at 68°F. (C.H.)

Fruit

16555 DEVELOPMENT OF A RADIATION PROCESS FOR SOME INDIAN FRUITS: MANGOES AND SAPODILLAS. Dharkar, S. D.; Savagaon, K. A.; Kumta, U. S.; Sreenivasan, A. (Atomic Energy Establishment, Trombay, India). J. Food Sci., 31: 22-8 (Jan.-Feb. 1966).

A low-dose radiation process, utilizing both radiation and heat, to conserve Alphonso mangoes and sapodillas (*Achras zapota*) packed in hermetically sealed cans was developed. The fruit, after peeling and slicing, was packed in sanitary cans containing sucrose syrup; enzymes were inactivated by heating for 10 min at 70°C. The cans were then evacuated for 6 min at a vacuum of 28 in. Hg, vacuum doubled-seamed, and irradiated with a total dose of 4×10^5 rad of γ radiation at room temperature. Organoleptic evaluation, vitamin retention, and sterility tests revealed that these processing conditions were optimal and produced an acceptable product. Canned mangoes showed progressively lower acceptability with radiation doses above 4×10^5 rad, as compared with a thermally processed product. Sapodillas, on the other hand, did not show appreciable deterioration when 1.2×10^6 rad was used for sterilization. Cans inoculated with 10,000 *Saccharomyces cerevisiae* cells and 500

Bacillus subtilis spores and irradiated with 4×10^5 rad were sterile after 2, 4, or 6 weeks of incubation at 30 or 37°C. In other studies with canned foods, similar results were obtained. (BBB)

377 RADIATION EFFECTS IN PECTINS. Dzamic, M. D.; Jankovic, B. R. (Inst. for the Application of Nuclear Energy in Agriculture, Belgrade). Int. J. Appl. Radiat. Isotop., 17: 561-6 (Oct. 1966).

Irradiation of pectins by γ rays causes decomposition of the molecules, which is observed as an extensive decrease in the specific viscosity of the solutions. The molecular weight also decreases by a factor in the range of 10^2 . The decomposition is intensified when solutions of pectin in water are irradiated. In that case, considerable de-esterification of carboxy groups is also found. Solid pectins are more stable. The difference may be due to the radiolytic products of water. Irradiation of pectins increases their thermal instability, which is observed as a decrease of the activation energy for thermal degradation. A comparison of activation energies with values for other compounds with similar polysaccharide structures, suggests that in all such materials the mechanisms for thermal decomposition and for radiolysis are very similar. The results indicate a considerable sensitivity of pectins to γ -irradiation. This suggests that special precautions are required if it is desired to treat natural products, containing both pectins and water, with γ rays. (auth)

Vegetables

1857 EFFECTS OF ^{60}Co γ RAYS ON NATTO. Urakami, C.; Sakamoto, R.; Takada, A.; Tanaka, H.; Furuhashi, N.; Uemura, T. (Osaka City Univ.). Radioisotopes (Tokyo), 15: 228-33 (Sept. 1966). (In Japanese).

Studies were made on effects of ^{60}Co γ rays, at dose levels of 0.63, 1.3, and 4.5×10^5 rad under ice-cooling, on Natto sealed in film in relation to its appearance, flavor, carbonyl, and TBA values, contents of free sugars, free amino acids, and the classes of phospholipids. No off-flavor appeared up to 1.3×10^5 rad but a pungent odor was detected at 4.5×10^5 rad. Such observations were reflected on the carbonyl and TBA values; no increase in the values up to 1.3×10^5 rad but a distinct increase was noted at $4.5 \times$

10^5 rad. The content of free sugars remained unchanged at all the dose levels. A total amount of free amino acids remained unchanged up to 1.3×10^5 rad but some increase at 4.5×10^5 rad. Amino acid analysis showed a considerable increase in amounts of methionine, leucine, tyrosine, arginine, and phenylalanine at the highest dose level but a decrease in amounts of lysine and histidine. Irradiation did not alter the classes of phospholipids present in the beans but caused a significant change in their fatty acid composition. Some alterations occurred in the classes of phospholipids of mucilage. The compounds appeared to be polyphosphatidic acid and phosphatidic acid, which were absent in the control sample, but were detected in the irradiated sample. (auth)

Milk and Eggs

14784 PRESERVATION OF CHEESE WITH COMBINED USE OF GAMMA RAYS AND SORBIC ACID. Bongirwar, D. R.; Kumta, U. S. (Atomic Energy Establishment, Trombay, India). *Int. J. Appl. Radiat. Isotop.*, 18: 133-4 (Feb. 1967).

Cheese was chosen as a typical milk product readily attacked by molds. Cobalt-60 gamma irradiation was employed, together with sorbic acid coated cellophane wrappers shown to inhibit surface mold growth. Sorbic acid is suitable for milk products because of its high partition coefficient towards oil/water and its low dissociation constant. The wrapped cheese was sealed in polythene bags, in a nitrogen atmosphere, to exclude oxygen, since irradiation is known to produce more carbonyl compounds in the presence of oxygen. Irradiation to 0.2 Mrad did not produce any "off flavor", but a "coconut-like" flavor was noticeable with samples exposed to 0.5 Mrad. For most of the experimental work a dose of 0.1 Mrad and sorbic acid coated wrappers (0.5% solution, sprayed four times) were employed. There was a marked synergistic effect on shelf-life of the cheese when stored at 37°C , but less so at room temperature and below. The samples retained their organoleptic attributes and were found acceptable. When binding substances were used together with sorbic acid for wrapper coating there was a further increase in shelf-life. Although the radiation doses employed were not lethal to molds, it is likely that they may cause permeability changes, thereby increasing the fungistatic effect of the sorbic acid. (auth)

9030 DEVELOPMENT OF LACTOBACILLUS LACTIS IN IRRADIATED MILK. Dupuy, P. (Institut National de la Recherche Agronomique, Versailles, France); Mocquot, G. pp 165-72 of *Applications des Rayonnements en France*. Vol. 1. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Irradiation of milk with doses of up to 200 krad promotes the growth of *Lactobacillus lactis*, as estimated by reduction in pH and increase of titratable acidity, whereas higher doses have an inhibitory effect. In the latter case a decreased maximum number of bacteria was also observed. Using irradiated milk or whey, it was shown that the reduction in growth is due to inhibitory substances formed during and after irradiation, rather than to a deficiency in growth factors. Further experiments in which irradiated lactose and casein solutions were added to nonirradiated milk showed that no inhibitory substances are present. Similarly, no difference was observed in the growth of *L. lactis* with varying fat content of irradiated milk. The possible use of microbiological techniques for investigation of biologically active substances, which may be produced in irradiated products, is discussed. (auth)

9040 EFFECTS OF IONIZING RADIATION ON POWDERED EGGS. Deschneider, A. R.; Meaux, R. (Ministry of Economic Affairs, Brussels). *Ann. Fals. Expert. Chim.*, 58: 73-85 (Jan.-Feb. 1965). (In French).

Results are reported from a study on the effects of γ radiation on the biochemical properties of powdered eggs. The egg powder was prepared from fresh eggs lyophilized to give a water content of 4%, packed in polyethylene bags under nitrogen, and irradiated with ^{60}Co to doses of 0.5, 1, and 2 Mrad. The irradiated egg powder was then examined by fractional extraction, column chromatography on carboxymethyl cellulose, paper electrophoresis, molecular filtration, spectrophotometry, and Kjeldahl analysis for nitrogen. The results of these analyses showed that irradiation caused the partial or total disappearance of carotenoids present in the acidified ether extract of lipids, diminution of proteins soluble in pH 4.0 buffer, and disappearance of characteristic protein fractions upon paper electrophoresis. The latter change was evident after the lowest radiation dose, 0.5 Mrad. None of the three changes was seen in non-irradiated egg powder stored for one year. (BBB)

Meat and Poultry

17679 THE INFLUENCE OF IONIZING RADIATION ON FATS. VI. POLYMERIZATION. Lueck, H.; Kohn, R.; Bach, H. (Deutsche Forschungsanstalt fuer Lebensmittelchemie, Munich). *Fette Seifen Anstrichmittel*, 66: 1063-71 (Dec. 1964). (In German).

In the polymerization of fats by 100-MRAD doses of either 1 MeV electrons or γ rays (^{60}Co source) below 45°C , in vacuum, the increase in viscosity for iodine value above 30 was independent of the double bond content. Such oils include linseed oil, Chinese wood oil, soya oil, sunflower oil, corn oil, peanut oil, olive oil, lard, beef suet, and the insoluble (in acetone) part of beef suet at 0°C . Other oils studied, with lower I values, were acetone-insoluble fractions of beef suet at higher temperatures, hydrated coconut fat, and trilaurin. Variations in the composition of fats under irradiation were studied, as well as general properties of irradiated oils, to include polymer fractions, peroxide content, viscosity, molecular weight by freezing point, dielectric constant, and dielectric loss factor. Changes in the IR and UV spectra of typical oils on irradiation are illustrated. Mechanisms for polymerization are discussed. (BBB)

18202 RADIATION PASTEURIZATION OF BROILER CHICKEN CARCASSES. Rhodes, D. N. (Meat Research Inst., Cambridge, Eng.). *Brit. Poultry Sci.*, 6: 265-71 (July 1965).

Irradiation of chicken meat with 2-MeV electrons, or of eviscerated whole carcasses with γ radiation, revealed that doses below 0.25 Mrad have no detectable effect upon the acceptability of the meat after cooking. The dose of 0.25 Mrad destroyed sufficient spoilage bacteria to extend the storage life (measured to the eventual onset of bacterial spoilage) by 3-fold at 1°C . During long-term chill storage, however, the quality of the meat declined rapidly, probably on account of changes inherent in the muscle. These considerations eliminate the possibility of long-term chill storage of pasteurized poultry so that studies were undertaken to define a process aimed at the direct marketing of broiler carcasses without freezing. For this purpose a max of 6 days was deemed necessary for distribution and retailing, with 1 further day to allow for the consumer holding the carcass before consumption. It was found that irradiation of standard broiler carcasses within 24 hr of slaughter with a dose of 0.15 Mrad of γ radiation was sufficient to give a shelf life of more than 6 days at 5°C , followed by 1 day at 15°C . The carcasses treated and stored in air remained unchanged in appearance and odor. After cooking, treated and stored carcasses were indistinguishable, when tasted in blind comparison tests, from unirradiated material held at -20°C for the same time. (BBB)

11165 INVESTIGATIONS INTO THE CAUSES OF COLOR CHANGES IN IRRADIATED MEATS. Mirna, A.; Gruenewald, T. (Bundesanstalt fuer Fleischforschung, Kulmbach, Ger.). *Fleischwirtschaft*, 16: 196-8 (Mar. 1964). (In German).

Studies were conducted on the chemical changes associated with color changes in irradiated meat. Pork meat, packaged in polyethylene, was irradiated by 60-kV x rays and 1-MeV electrons to doses up to 3 Mrad. By extraction of meat, irradiated with doses of 0.10 Mrad and higher, it was possible to detect formation of nitrite. Nitrite formation was dose dependent up to 1-MeV doses. At 1 MeV the nitrite disappeared from meat about 3 days after irradiation, but was still present at 5 days after lower doses (0.1 Mrad). Since it is possible that nitrite could react with myoglobin in meat to form nitrosomyoglobin, attempts were made to detect this substance spectrophotometrically in acetone extracts of irradiated meats. However, results were negative. Possible ways in which nitrite could form in irradiated meat are discussed. (BBB)

13093 THE EXTENSION OF THE SHELF-LIFE OF POULTRY BY THE COMBINED APPLICATION OF TETRACYCLINE-1-DODECYL-4-BENZENE-SULFONIC ACID AND γ -RADIATION. Kiss, I.; Farkas, J. (l'Industrie Alimentaire, Budapest). *Int. J. Appl. Radiat. Isotop.*, 18: 65-9 (Jan. 1967). (In French).

The combined effect of immersion in a 20 mg/l tetracycline-1-dodecyl-4-benzenesulfonic acid solution and a γ ray treatment 100 to 200 Krads dose level was investigated. By treating the poultry with either the antibiotic or irradiation, its shelf-life could be increased two or threefold. When the antibiotic treatment was combined with irradiation at 100 Krads the keeping quality increased at least sixfold. Using the antibiotic and 200 Krads dose an eightfold increase could be achieved, as compared to that of the untreated control sample. The qualitative composition of the

microbial population was also investigated, and the antibiotic and radioresistance of strains composing the majority of the population, as well as that of the psychrophil strains, was established. (auth)

13088 IONIZING RADIATIONS AND THE CONTROL OF TRICHINOSIS. Barriga, Omar O. (Univ., Chile, Santiago). Bol. Chil. Parasitol., 19: 89-92 (July-Sept. 1964). (In Spanish).

Data relating to the use of ionizing radiation to eliminate trichinosis are reviewed, and feasibility and economics of use of this means to eradicate human and porcine infestation in Chile are considered. The human and porcine incidence of trichinosis in Chile is 12.5 and 0.37%, respectively. Irradiation of the larvae with doses of 5000 R results in sterile adult *Trichinella spiralis*. Pork can be treated with ^{60}Co γ radiation at doses of 30,000 rep to destroy the organism, and the use of this as a commercial process is examined. An irradiation plant with a ^{137}Cs source and a capacity for 2000 porcine carcasses per day is described. It would cost ~\$566,000 (U.S.). The expense of irradiating pork would be ~\$0.47 per 100 kg. (BBB)

6741 CONSUMER SURVEY FOR ACCEPTANCE EVALUATION OF CURED HAM TREATED BY A COMBINATION OF HEAT AND IRRADIATION. Hansen, Poul-Ivar E. (Danish Meat Research Inst., Roskilde). Food Technol., 20: 99-103 (Feb. 1966).

Commercially sterile canned hams were produced by a combination of a heat treatment to a center temperature of 65-70°C plus doses of about 0.5 Mrad γ radiation. This gave a ham with a shrinkage of 6-12%, depending on size, compared to a 25-30% shrinkage in normally heat-treated controls. The irradiated hams had good texture and color. It was previously found that some off-flavor arose, and experienced taste panels scored the irradiated hams 1½-2 points lower than control hams on an 11-point hedonic scale. The flavor of this cured ham was then compared by an untrained, consumer panel with the flavor of cured ham conventionally heat-treated, on a 5-point hedonic scale. The panel consisted of 150 families, selected at random in a limited geographical area, about 350 people in all. They were informed in advance that the experiment involved irradiated food. In two consecutive weeks they received slices of ham from either an irradiated ham or a control ham, the four possible combinations of irradiated and un-irradiated ham being used. By means of test-retest data and check questions the panel was shown to be consistent, and data for identical samples in various groups indicated that randomizing of the panel into different groups had succeeded. A higher significant difference in flavor was found between irradiated and control ham. The difference in score in groups where a direct comparison was possible was higher than ¾ scale point in favor of the control ham. The results thus confirm the findings of small expert taste panels made earlier. Most unfavorable comments were connected with the flavor of the irradiated ham, taste as well as smell. The smell was characterized as burnt, sulfurous, and in a few cases, repulsive. Many tasters characterized the irradiated samples as the juicier of the two. This confirms the results of experienced taste panels, who found superior texture and consistency in irradiated hams. It appears that the consumer attitudes to irradiated vs conventionally heat-treated canned hams could have been predicted closely from the results obtained by trained taste panels. (BBB)

9038 CONTAMINATION OF MEAT SUPPLIES. PART I. SALMONELLA AND STAPHYLOCOCCUS. PART II. CLOSTRIDIUM WELCHII AND TOXOPLASMA. Hobbs, Betty C. (Central Public Health Lab., London). Mon. Bull. Min. Health, 24: 123-34; 145-51 (May; June 1965).

Control of meat contamination by pathogenic organisms is discussed, and methods for reducing the chain of infection from farm to consumer are presented. Recommendations include: an amendment of the Slaughterhouse Regulations to limit the holding of pigs for a period of not longer than 2 days; the use of γ irradiation for animal feed known to be a source of salmonellas; and the use of γ irradiation for packs of imported frozen boneless meat that cannot be freed from salmonellas by improved hygiene during production. (TSS)

Seafood

6744 PRESERVATION OF THE SARDINE SARDINELLA MELANURA BY LOW-DOSE GAMMA RADIATION. Hashish, S.; Hussein, M. F.; Abdel-Baki, M. M.; Roushdy, H. M.; Hassan, Y. M. (Atomic Energy Establishment, Cairo). J. Fish. Res. Board Can., 23: 601-6 (Apr. 1966).

Effectiveness of low doses of γ radiation for fish preservation as compared with chlortetracycline (CTC) treatment was examined. Irradiation of the sardine *Sardinella melanura* with 15,000 or 23,000 rad from a ^{60}Co source increased the storage life at 1°C. During storage the rates of increase in pH, total volatile nitrogen (TVN), tyrosine value (TV), and bacteriological count (BC) were diminished by raising the radiation dose and those for TVN, TV, and BC also by treatment with CTC. The edibility periods, as judged organoleptically, were 4 days for untreated samples, 8 and 11 days for samples irradiated at 15,000 and 23,000 rad, and 12 days for samples treated with CTC. After 8 days of storage the TVN and TV values for samples treated with CTC were lower in relation to the values just after treatment than were those for samples irradiated at either dose. At 8 days, the BC values for samples treated with CTC were 136 times those just after treatment, in comparison with 11 times for the irradiated samples; however, the counts at 8 days were less than half as high for samples treated with CTC as for those irradiated at 23,000 rad. The protection factors were 2 and 2.75 for the irradiated samples and 3.0 for the CTC treatment. Though the BC for treatment with CTC was much higher than for either of the irradiation treatments, the actual counts at 8 days after treatment were less than half as high for CTC as for irradiation (3.4 million vs 7.5 and 26 million). That the BC value, which is a direct index of the rate of fish deterioration as a result of bacterial growth, was lower for irradiation than for treatment with CTC is in keeping with earlier findings that antibiotics have bacteriostatic effects while irradiation has bactericidal effects. (BBB)

Hides

6685 EFFECT OF ULTRAVIOLET AND GAMMA RADIATIONS ON THE PROPERTIES OF SKINS AND LEATHER. Guha, N. N.; Ramanathan, N.; Nayudamma, Y. (Central Leather Research Inst., Madras). Leather Sci. (Madras, India), 12: 256-62 (July 1965).

The physical and chemical modifications in raw goat skins and variously tanned leathers caused by uv and γ radiations are reported. Doses of 5000 erg/sec cm² uv light and 30, 60, and 90 Mrad of ^{60}Co radiation were used. Color changes as well as alteration of tensile strength, elongation at break, and double-hole stitch tear strength were tested. The effects increased with the dose. The general trend of color change is the same after uv and γ irradiation, whereas uv irradiation made it lighter in color. The physical properties deteriorated on exposure to both of these radiations. The degradation in physical properties was more severe with γ radiation and increased progressively with the dose. A comparison made between the effects of uv and γ irradiation suggests that the more deleterious effects of γ radiation can be attributed to greater depth of penetration, and higher energy. The greater resistance of vegetable-tanned leather observed is explained in terms of the effects of these radiations on the chemicals contained in the vegetable tanning materials. (BBB)

PROCESS RADIATION DEVELOPMENT

Polymerization

8330 (AEC-tr-6806) ANNUAL REPORT OF THE JAPANESE ASSOCIATION FOR RADIATION RESEARCH ON POLYMERS, VOLUME 6, 1964-1965. Translation of Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 6: 1-322(1964-1965). 365p. Dep. mn. CFSTI \$3.00 cy, \$0.65 mn.

The English-language portions of the report, including abstracts and entire articles, are reproduced in their original form. Thirty-three articles, which were previously abstracted in NSA from the original language, are included. (P.C.H.)

3133 RADIATIONNAYA KIMIYA POLIMEROV. (Radiation Chemistry of Polymers). Karpov, V. L. (ed.). Moscow, Izdatel'stvo Nauka, 1966. 408p.

Ninety reports presented at the Symposium on Polymer Radiation Chemistry, November 23-28, 1964 in Moscow, include data on γ -induced polymerization, radiation synthesis of graft polymers, radiochemical transformations in polymers, radioinduced cross-linking and modification in polymers, and radiation stability of polymer materials. (R.V.J.)

12485 METHOD FOR PRODUCING POLYVINYL CHLORIDE RESIN COMPOSITIONS. Suzuki, Fumio (to Sumitomo Electric Industries, Ltd.). Japanese Patent 1966-1423. Feb. 3, 1966. Filed Mar. 11, 1963.

Resin compositions of high thermal stability and solvent resistance can be obtained by the irradiation of polyvinyl chloride resins containing long-chained ester compounds, such as polyesters, as the compounded ingredients. Other properties resultant from the process, including mechanical properties (tensile strength, elongation, hardness, etc.), electric properties, and appearances cause no inconvenience in actual use of the resins. (NSA of Japan)

19661 FORMATION OF HIGH BOILING PRODUCTS OF RADIOLYSIS BY RADIATION MIXTURES OF PERFLUOROBENZENE WITH PERFLUOROCYCLOHEXANE AND PERFLUORONONANE. Khranchenkov, V. A. At. Energ. (USSR), 21: 375-8(Nov. 1966). (In Russian).

The dependence of the formation of polymer products during the (n, γ) irradiation of mixtures of hexafluorobenzene with perfluorocyclohexane and n-perfluorononane on the concentration of the hexafluorobenzene was determined. A hypothesis on the inhibiting effect of hexafluorobenzene during the radiolysis of perfluorocyclohexane was proposed. It was established that during the radiolysis of n-perfluorononane, hexafluorobenzene plays the role of an agent initiating polymerization. (tr-auth)

15932 RADIATION-INDUCED POLYMERIZATION OF NITROETHYLENE. Yamaoka, Hitoshi; Williams, Ffranco; Hayaishi, Koichiro (Kyoto Univ.). Trans. Faraday Soc., 63: 376-81 (Feb. 1967).

A study of radioinduced polymerization of nitroethylene indicated an anionic mechanism involving free ions. By use of hydrogen bromide as an anionic scavenger, the kinetics of polymerization was investigated. $G(\text{initiation})$ is about 3, which is much larger than the value (0.1) obtained for many cationic polymerizations of hydrocarbons. This difference may be explained in terms of the large dielectric constant and high electron affinity of this monomer. By kinetic analysis, the propagation rate constant k_p at 10°C is estimated to be $4 \times 10^7 \text{ M}^{-1} \text{ sec}^{-1}$. $G(\text{initiation})$ is given by $G(\text{monomer})/\text{degree of polymerization}$. (auth)

8377 KINETIC STUDY OF THE RADIOCHEMICAL POLYMERIZATION OF ISOPRENE. Hirschberger, Andre; Marchal, Jean (Centre de Recherches sur les Macromolecules, Strasbourg). pp 131-4 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Kinetics of the radiochemical polymerization of pure degassed isoprene were studied between -196 and 40°C. They are explained by the superposition of two independent polymerization mechanisms. The first, at the monomolecular termination, is probably cationic, whereas the second, at the bimolecular termination, is radical. (tr-auth)

4578 METHOD FOR RADIATION-POLYMERIZATION OF ISOCYANIC ACID. Hamada, Michio (to Ube Industries Ltd.). Japanese Patent 1965-22595. Oct. 6, 1965. Filed Jan. 22, 1963.

In the method proposed for radioinduced polymerization of isocyanic acid, a linear polymer of isocyanic acid with a high degree of polymerization is produced by irradiating the monomer with ionizing radiation in the temperature range from -200 to 50°C; the monomer may be either in the solid or in the liquid state by dissolving it with an appropriate solvent. (NSA of Japan)

8352 POLYMERIZATION OF BUTADIENE SULFONE. Minoura, Yuji; Nakajima, Shigemitsu (Osaka City Univ.). J. Polym. Sci., Pt. A-1, 4: 2929-44(Dec. 1966).

Polymerization of butadiene sulfone (BdSO_2) by various catalysts was studied. Azobisisobutyronitrile (AIBN), butyllithium, tri-n-butylboron ($(n\text{-Bu})_3\text{B}$), boron trifluoride etherate, Ziegler catalyst, and γ radiation were used as catalysts. Butadiene sulfone did not polymerize with these catalysts at low temperatures (below 60°C.), but polymers were obtained at high temperature with AIBN or $(n\text{-Bu})_3\text{B}$. The polymerization of BdSO_2 initiated by AIBN in benzene at 80 to 140°C was studied in detail. The obtained polymers were white, rubberlike materials and insoluble in organic solvents. The polymer composition was independent of monomer and initiator concentrations and reaction time. The sulfur content in polymer decreased with increasing polymerization temperature. The polymers prepared at 80 and 140°C have the compositions $(\text{C}_4\text{H}_6)_{1.55}(\text{SO}_2)$ and $(\text{C}_4\text{H}_6)_{3.14}(\text{SO}_2)$, respectively, and have double bonds. These polymers were not alternating copolymers of butadiene with sulfur dioxide. The polymerization mechanism was discussed from polymerization rate, polymer composition, and decomposition rate of BdSO_2 . From these results, the polymerization was thought to be "decomposition polymerization," i.e., butadiene and sulfur dioxide, formed by the thermal decomposition of BdSO_2 , copolymerized. (auth)

12484 METHOD FOR PRODUCING THERMALLY-STABLE POLYMERS OF FORMALDEHYDE. Fukui, Kenichi (to Sumitomo Chemical Co., Ltd.). Japanese Patent 1966-235. Jan. 11, 1966. Filed Aug. 26, 1963.

A method is proposed for producing thermally-stable high polymers of formaldehyde with sufficient mechanical strength for use as plastic materials by irradiating mixtures of formaldehydes and ketenes with an ionizing radiation at temperatures above -50°C with carbon dioxide or an organic carboxylic acid anhydride added as a third component. Addition of inorganic or organic acid anhydrides such as CO_2 , maleic anhydride, succinic anhydride, or itaconic anhydride to the mixture had the effect of suppressing the undesirable chain terminating reaction and resulted in the elimination of polymer molecules of undesirable low molecular weight even at a relatively high temperature near the ambient temperature. (NSA-Japan)

12481 NOVEL METHOD FOR POLYMERIZATION OF FORMALDEHYDE. Fukui, Kenichi (to Sumitomo Chemical Co., Ltd.). Japanese Patent 1966-1431. Feb. 3, 1966. Filed Feb. 13, 1963.

Formaldehyde can be polymerized with a high G-value by irradiation with an ionizing radiation in the presence of acid anhydrides at a temperature above -20°C, to give high polymers of formaldehyde with excellent plastic properties, not inferior to polyformaldehyde resins obtainable by the conventional methods. (NSA of Japan)

8378 THE STRUCTURE OF SOLID MIXTURES OF PARAFFIN OIL WITH VINYL MONOMERS. INTERPRETATION OF RADIOCHEMICAL POLYMERIZATION IN THEIR MIXTURES AT LOW TEMPERATURES. Spritzer, Charles; Sella, Claude; Chapiro, Adolphe (CNRS, Bellevue, France). pp 135-8 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Examination of mixtures of methyl methacrylate or of styrene with paraffin oil showed that at low temperature the monomers crystallize in the pure state at temperatures much below their respective melting points. A phase separation is produced during cooling and the monomer phase undergoes a very important supercooling because of its dispersion in fine droplets in the vitreous mass of the paraffin oil. Polymerization is effected in these isolated liquid droplets under conditions that recall those occurring in emulsion polymerizations. (tr-auth)

5929 THE EFFECTS OF TEMPERATURE ON THE γ -RADIATION-INDUCED POLYMERIZATION OF ETHYLENE. Machi, Suet; Hagiwara, Miyuki; Gotoda, Masao; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Gunma). Bull. Chem. Soc. Jap., 39: 2696-2702(Dec. 1966).

The gamma radioinduced polymerization of ethylene was carried out over the wide range of temperature from 30 to 200°C at pressure ranging from 100 to 400 kg/cm² and at dose rates from $2 \times$

10^3 to 4×10^5 rad/hr. It was found that the rate of polymerization is rapidly accelerated at 30°C, that the degree of acceleration decreases with an increase in the reaction temperature, and that above 100°C the rate is independent of the time. It was correspondingly found that the molecular weight of the polymer increases with the reaction time, at 30°C, that its increment for a unit of time decreases with an increase in the temperature, and that the molecular weight is independent of the time above 100°C. From a kinetic study it was concluded that the rate of the termination reaction, which is almost eliminated at 30°C, increases with the temperature and attains a value comparable to that of initiation above 100°C. The dose rate exponents of the polymerization rate and molecular weight were found to vary with the reaction temperature. Under a constant pressure, the polymer yield was found to decrease with the temperature from 30 to 60 to 80°C, and then to increase at high temperatures from 80 to 200°C. On the other hand, the molecular weight of the polymer simply decreases with the temperature from 30 to 200°C. The chain transfer reaction is considered to be almost negligible at 30 to 70°C. The number of polymer chains for a constant reaction time and monomer concentration is independent of the temperature from 30 to 70°C, while it increases with the temperature from 70 to 200°C. The effects of pressure on the polymer yield and molecular weight were also investigated at 140°C. (P.C.H.)

118 THERMOMECHANICAL PROPERTIES OF IRRADIATED POLYAMIDES CROSS LINKED BY CHROMIUM CHLORIDE. Afanas'ev, A. M.; Pavlov, S. A. (Moscow Technological Inst. of Light Industry). *Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.*, 9: 480-5 (1966). (In Russian).

The influence of cross-linking chromium compounds followed by irradiation on the thermomechanical properties of mixed polyamide films was studied. Addition of chromium chloride transformed the film structure from amorphous-crystalline to amorphous, increasing the heat resistance of the film. At 25 to 300°C the film lost its fluidity; however, under integral γ doses of 500 MRAD the polyamide films containing chromium chloride increased their cold-fluidity and at temperatures close to melting turned into a viscous fluid. It was indicated that radiation doses exceeding by an order of magnitude the doses capable of producing gels of the initial polyamides are necessary to produce even small gel links between the macromolecules of the polyamide films cross-linked by chromium(III) salts. (R.V.J.)

8350 TELOMERIZATION OF PROPYLENE WITH CARBON TETRACHLORIDE INDUCED BY γ -RADIATION. Takehisa, Masaaki; Urano, Yokichi; Yasumoto, Masahiko. Tokyo Kogyo Shikensho Hokoku, 61: 478-86 (Nov. 1966). (In Japanese).

The rate of telomerization was determined dilatometrically in the following conditions; temperature, 10 to 70°C; pressure, 150 to 1,000 mmHg; dose rate, 2×10^5 to 7×10^5 RAD/hr. By a proposed rate equation, which was derived with a consideration of a degradative chain transfer to propylene, the ratio of the rate constants of the hydrogen abstraction from propylene by a chain-carrying radical, which produced stable allyl radical, to the addition reaction of propylene with a chain-carrying radical was found to be in the range from 0.002 (70°C) to 0.01 (10°C). The apparent activation energy of the hydrogen abstraction and addition reactions were nearly 0 and 5.3 kcal/mole, respectively. Distribution of the products observed by a gas chromatographic analysis clearly indicated the formation of the various minor products, such as isopropyl chloride, allyl chloride, hexadiene-1,5, chloroform, 4,4,4-trichlorobutene-1, and 1,1,1-trichlorobutane, which originated from the degradative chain transfer reactions. The G-values of these products gave a satisfactory agreement with the ratio of the rate constants obtained from kinetic studies. The degradative chain transfer constants and the fate of the allyl radical were discussed. (auth)

8351 TELOMERIZATION OF ETHYLENE WITH CYANOGEN CHLORIDE INDUCED BY γ -RADIATION. Takehisa, Masaaki; Hosaka, Yoshinobu. Tokyo Kogyo Shikensho Hokoku, 61: 501-2 (Nov. 1966). (In Japanese).

Telomerization of ethylene with cyanogen chloride induced by γ -radiation was carried out at 10 to 60°C, pressures of 60 to 185 kg/cm², reaction durations of 65 to 120 hr, and dose rate of 1.4×10^5 RAD/hr. A series of telomers, $\text{Cl}(\text{C}_2\text{H}_3)_n\text{CN}$, where n is inte-

gers between 2 and 4, was obtained and yields quantitatively determined by gas chromatography. Sum totals of the G-values of the telomer formation were around 10 regardless of the reaction conditions. Addition of NaCN to the reaction system increased the yield of the telomer formation around 2 fold, but the addition of azo-bis-isobutyronitrile had no effect. Essentially the same distribution of the degree of the telomerization compared with the conventional processes was observed. (auth)

10396 EFFECT OF CROSSLINKS ON THE RECOMBINATION OF RADICALS IN ELASTOMERS. Kvashenko, Yu. Yu.; Kuzminskii, A. S.; Fedoseeva, T. S. *Vysokomol. Soedin.*, 8: 2150-4 (Dec. 1966). (In Russian).

Radical decay in γ -irradiated sulfur vulcanates based on natural rubber was studied. In a wide temperature range sulfur bridges intensify the process and the radical decay rate is higher in polysulfide vulcanizates than in monosulfide ones. In glassified polymer, sulfur is supposed to facilitate intra- and intermolecular migration of free valency. (auth)

1403 METHOD FOR PRODUCING POLYVINYL ALCOHOL-BONDED WHETSTONE. Horie, Tomohiro. Japanese Patent 1965-21395. Sept. 22, 1965. Filed Nov. 12, 1962.

A method is proposed for producing a highly effective resin-bonded whetstone with improved mechanical properties. A homogeneous mixture of solid polyvinyl alcohol and wheat grains, having a water content of 20%, is irradiated with either ultrasonic waves or ionizing radiation in the presence of heat in the mold under pressure. The product is insoluble or only slightly soluble in water. (NSA of Japan)

17684 RADIATION INDUCED POLYMERIZATION OF ISOPRENE IN THE AQUEOUS SOLUTION OF SILVER NITRATE. Fujioka, Syuji (Toyo Rayon Co., Ltd., Japan); Hayashi, Koichiro. Kogyo Kagaku Zasshi, 69: 736-41 (Apr. 1966). (In Japanese).

The formation of a 1:2 complex between isoprene and silver nitrate was confirmed spectrometrically, and the equilibrium constant (K) and the extinction coefficient (ϵ) were estimated to be 0.18 and 1.4, respectively. The polymerization mechanism was assumed to be radical based on the effects of inhibitors. The polyisoprene obtained had a cross linked structure and did not give a distinct solubility and melting point. The 1,2-structure was predominant in polyisoprene configuration. (NSA of Japan)

17664 RADIATION-INDUCED CATALYTIC POLYMERIZATION. I. THEORY. Temkin, A. Ya. (Topchiev Inst. of Petrochemical Synthesis, Moscow). *J. Polym. Sci., Pt. A-2*, 5: 211-23 (Jan. 1967).

The kinetics of radiation polymerization on a solid catalyst is discussed, under the condition that only linear termination of the chain takes place. All the kinetic equations are balance equations of particles of each type adsorbed by unit mass of the catalyst, and this makes it possible to account for the effect on the kinetics of the time dependence of the magnitude of the part of its surface on which the reactions considered may take place. Integro-differential equations are used for calculating the molecular-weight distribution of the resulting polymer; this ensures higher accuracy of the formulas obtained than when differential equations are used and makes it possible to eliminate a number of limitations generally involved in the transition to differential equations. An expression was found for the molecular-weight distribution of the polymer product, which allows for the possibility of radioinduced catalytic polymerization on the resulting adsorbed polymer. Expressions were derived for the average molecular weight and yield (weight and molecular) of the polymer formed. Asymptotic formulas were obtained (for large irradiation times) for all the above values. The conclusions that can be drawn concerning the mechanism of the process based on a comparison of the formulas obtained with kinetic curves plotted from experimental data are given. It is shown how such a comparison can be utilized for calculating the rate constants for polymerization and chain termination reactions. (auth)

17662 EFFECT OF COMPLEXING AGENTS ON POLYMERIZATION OF ALLYL MONOMERS. Kulikova, V. F.; Savinova, I. V.; Zubov, V. P.; Kabanov, V. A.; Polak, L. S.; Kargin, V. A. (Moscow State Univ. Inst. Petroleum Chemical Synthesis, Academy of Sciences, USSR). *Vysokomol. Soedin.*, 9: 299-302 (Feb. 1967). (In Russian).

The rate of polymerization of allylacetate (AAc) and allyl alcohol (AA) initiated by γ -irradiation or photochemically, increased in presence of ZnCl_2 . In coming from pure monomer to a 1:1 complex in case of AAc or to a complex of AA with ZnCl_2 of 2:1 composition, the rate of polymerization increased by 5.5 to 6 times and 22 times, correspondingly. The product of AAc polymerization was a branched polymer of high molecular mass. The rate of initiation in the AAc- ZnCl_2 system was determined and the ir-spectrum of the AAc- ZnCl_2 complex was studied. On the basis of the results obtained it was proposed that the role of the complexing agent in the increase of the polymerization rate may consist of activation of allyl radicals of chain transfer and formation of mobile organized array of monomer molecules. (auth)

Graft

15945 INFRARED SPECTROSCOPY IN THE INVESTIGATION OF RADIATION INDUCED GRAFT COPOLYMERIZATION. DasGupta, Sharda (Atomic Energy of Canada Ltd., Ottawa). *Can. Spectrosc.*, 12: 16-19 (Jan. 1967).

Infrared spectroscopy was found to be a valuable radioinduced graft copolymerization reactions. Gamma radiation when absorbed in significant quantities has a profound effect on the molecular structure of materials and can, under controlled conditions be made to initiate or promote a multitude of chemical reactions. In order to find the best conditions for the synthesis of specific graft copolymers with the required properties, it is necessary to understand the mechanism of the reactions involved, to obtain proof of the formation of grafts and to study the structure of the materials formed. The use of infrared spectroscopy for such studies in the field of natural and synthetic fibers, graft copolymers, radiation resistant greases and lignin resins was discussed. (auth)

10395 AN ATTEMPT AT RADIATION GRAFTING OF MALEIC ANHYDRIDE ON POLYETHYLENE. Zurakowska-Orszagh, Janina; Gabara, Wlodzimierz (Univ. of Warsaw). *Nukleonika*, 11: 669-71 (1966).

Attempts made to graft maleic anhydride on polyethylene by gamma radiation in acetone or benzene solutions showed comparatively low numerical values for direct grafting. Post-effect grafting took place readily at 120°C. The most probable mechanism is cross linking, which explains the insolubility and infusibility of the grafted foil that was observed. (P.C.H.)

10403 POLYVINYL CHLORIDE GRAFT COPOLYMERS. Pinner, Solomon Harris. (to B. X. Plastics Ltd.). *British Patent* 1,050,781. Dec. 7, 1966. Filed Sept. 7, 1961.

A process for the manufacture of crosslinked graft copolymers comprises subjecting a graft copolymer from polyvinyl chloride or a vinyl chloride copolymer and one or more ethylenically unsaturated monomers to the action of a crosslinking agent; such as ionizing radiation, ultraviolet radiation in the presence of a sensitizer, a free-radical polymerization initiator, or an elastomer curing agent or a polyanhydride or polyamine capable of reacting with epoxy plasticizers for polyvinyl chloride, or a combination of any two of these to effect crosslinking. (B.L.M.)

5936 GRAFT POLYMERIZATION OF STYRENE ON POLYPROPYLENE. Kurilenko, A. I.; Danilov, E. P.; Temnikovskii, V. A. *Vysokomol. Soedin.*, 8: 2024-31 (Nov. 1966). (In Russian).

The graft polymerization of styrene from gaseous phase on polypropylene fibers previously γ irradiated in vacuo was studied. Proposals concerning the mechanism of the process and structure of the grafted fibers were based on a comparison of the results of the kinetics of sorption, graft copolymerization, and radical decay in the course of polymerization along with data from ir-spectroscopy and thermomechanic measurements. Oriented structures of grafted polystyrene were formed directly on synthesis. (auth)

5965 METHOD FOR PRODUCING ELASTOMERS BY GRAFT-COPOLYMERIZATION. Amamiya, Ayao; Suzuki, Ikuro (to Nichibo Co., Ltd.). *Japanese Patent* 1965-26555. Nov. 17, 1965. Filed Sept. 26, 1962.

A method is proposed for producing graft-copolymers with improved or modified elastic and mechanical strength properties by grafting diolefin monomers, such as isoprene, onto organic polymers in the presence of trivalent titanium salts without damaging the original polymers. Organic polymers irradiated with ionizing radiation in the air or in oxygen at more than 5×10^{14} R are brought into contact with diolefin monomers, such as isoprene, in the presence of trivalent titanium salts of concentration over 1×10^{-5} mole/l. (NSA of Japan)

19660 GRAFT COPOLYMERIZATIONS OF GASEOUS VINYL CHLORIDE AND VINYLIDENE CHLORIDE ON PREIRRADIATED POLYPROPYLENE. Hayakawa, Kiyoshi; Kawase, Kaoru (Government Industrial Research Inst., Nagoya Japan). *J. Polym. Sci.*, Pt. A-1, 5: 439-54 (Mar. 1967).

The graft copolymerizations onto the preirradiated polypropylene fibers of gaseous vinyl chloride and of gaseous vinylidene chloride were carried out. The fibers were preirradiated with γ rays from a ^{60}Co source at -78°C in air to a total dose of 8×10^5 RAD, and were thus presumed to contain peroxide radicals, which were active in grafting at ordinary temperature. The volume decrease of monomers at constant pressures due to the sorption and the grafting reaction was followed automatically at temperatures ranging from -10 to 80°C . The net monomer consumption through the grafting process was estimated by subtracting the volume change due to the sorption from the total volume change of monomers. In general, the extent of grafting was lower at the higher grafting temperature and the decrease of the grafting activity of fibers was also accelerated. The grafting was found to increase almost linearly with the logarithm of the reaction time and the logarithm of the radiation dose to the fibers. The extent of grafting was also proportional to the vapor pressure of monomer at a given reaction temperature and was supposed to be controlled by the amount of the monomer adsorbed. Raising the irradiation temperature higher than 0°C brought about a marked decrease in the activity of preirradiated polypropylene. The grafting activity was successfully retained by the polymer for at least a fortnight at -78°C . (auth)

114 GRAFTING OF METHYL METHACRYLATE TO BUTYL RUBBER UNDER THE INFLUENCE OF GAMMA RADIATION. Tashmukhamedov, S. A.; Tillaev, R. S.; Latypov, T.; Usmanov, Kh. U. (Tashkent State Univ.). *Uzbek. Khim. Zh.*, No. 5, 59-62 (1965). (In Russian).

Graft copolymers of butyl rubber (copolymer of isobutylene with 2.0 to 3.0% isoprene) with methyl methacrylate were synthesized radiochemically by simultaneously irradiating a mixture of the polymer and monomer in the absence of atmospheric oxygen with ^{60}Co gamma rays. After extraction of the polymethyl methacrylate homopolymer (PMMA), the degree of grafting and yield of the graft copolymer decreased with increasing irradiation dose for a polymer-to-monomer ratio of 1:1 and 1:0.6, and also in the solvent dichloroethane. The copolymers formed had a variable composition; their formation was confirmed by turbidimetric titration. A study of the kinetics of swelling of the copolymers in various liquids showed that the nature of the side chain in the graft copolymer causes a decrease in the affinity of the system obtained for some liquids and an increase for others. A study of the viscosity of solutions of the graft copolymers in benzene at 30°C revealed that as the content of graft PMMA in the copolymer diminishes (with rising irradiation dose), the intrinsic viscosity of the solutions decreases. This is attributed not only to a drop in the proportion of graft PMMA in the copolymer but also to the degradation of macromolecules of the initial polymer under the influence of gamma radiation. (ATD)

127 METHOD FOR GRAFT-COPOLYMERIZING BUTADIENE ON TO POLYOLEFINS. Ohashi, Hachiro (to Nippon Telegraph and Telephone Public Corp.). *Japanese Patent* 1965-21272. Sept. 21, 1965. Filed Aug. 18, 1962.

In the method proposed for the graft-copolymerization of butadiene and polyolefins, polyolefins are irradiated with high-energy ionizing radiation in the temperature range of 20 to 80°C while in contact with butadiene vapor. Later investigations showed that the method may be applicable to industrial production. (NSA of Japan)

126 RADIATION INDUCED GRAFT COPOLYMERIZATION. Das Gupta, Sharda; Slobodian, James T. (to Atomic Energy of Canada Ltd.). *Canadian Patent* 742,194. Sept. 6, 1966.

A process is described for the graft copolymerization of a vinyl monomer in solution to linear shaped articles of polymeric material, such as fabrics, threads, and sheets. Nylon, cellulose, and paper rolled on a rod are immersed

in the vinyl monomer solution and exposed to gamma radiation, such as a ^{60}Co source. Homopolymers form mainly in the outer layers of the roll and must be extracted with an organic solvent or discarded. The major portion of the roll, however, requires no extraction treatment. Seven examples are given to indicate the details of processing. (F.S.A.)

19688 SOME PROBLEMS ON THE GRAFTING OF FIBERS. Sakurada, Ichiro. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 17-23(1965-1966).

The application of radioinduced polymerization to the production of improved fibers is discussed. Work being done to improve the dyeability and heat resistance of synthetic fibers is reviewed. Attempts to improve the crease resistance and strength of cellulose fibers by grafting with synthetics are discussed. Other problems of radiation graft polymerization are also mentioned. (J.G.B.)

8373 GRAFTING OF STYRENE-ACRYLONITRILE MIXTURES IN POLYVINYL CHLORIDE BY THE DIRECT RADIO-CHEMICAL METHOD. Chapiro, Adolphe; Jendrychowska-Bonamour, Anna-Maria (CNRS, Bellevue, France). pp 65-76 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The radiochemical grafting of mixtures of styrene and acrylonitrile on polyvinyl films at 20°C was studied. The reaction took place in a gel of the polymer swollen by the two monomers. The degree of swelling of the polyvinyl chloride was much larger in some mixtures than either of the two monomers alone; the swelling was at a maximum for the mixture containing 30% acrylonitrile. The curve representing the grafting rate as a function of the composition of the monomer mixture has a complex form. Studies of the radiochemical copolymerization of these two monomers showed that a part of this complexity is caused by the precipitation of the copolymer in the reaction medium for acrylonitrile concentrations higher than 95%. The differences observed between the curves of grafting and copolymerization were interpreted by perturbation introduced in the grafting reaction by the effect of the gel and by diffusion of the monomers. When the reaction conditions are such that the grafting kinetics is not controlled by the diffusion, the composition of the grafts is close to that of the statistical copolymer obtained in the same mixture of the two polymers. (tr-auth)

8374 RADIATION GRAFTING OF 4-VINYLPYRIDINE ONTO PVC FIBERS. Roudeix, H. (Center of Nuclear Research, Saclay, France). pp 77-86 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966.

The radiation grafting of 4-vinylpyridine on polyvinyl chloride fibers was studied using methanol as a monomer solvent. In fibers unswollen before irradiation the grafting reaction was almost nonexistent for monomer concentrations below 20%. In swollen fibers grafting ratios of 90% were obtained with solutions of 30, 40, and 50% monomer concentrations, but only 20% grafting was obtained with a 10% vinylpyridine solution. Studies of 40% 4-vinylpyridine solutions showed an induction period of 5 to 6 hours for the grafting of unswollen fibers. The homopolymer formation in 40% solutions was also determined. When grafting was superficial and below 15 to 20%, the fibers kept the aspect of new fibers and the flexibility and hand were not affected. They had a good aptitude for acid dyeing. With fibers grafted throughout the whole section, dyeing was not successful. The grafted fibers were insoluble in all solvents tested. Some mechanical tests indicated that the grafted copolymer behaves like an inert form, which does not participate in the strength of the fibers. (J.S.R.)

17685 GAMMA-RAY INDUCED GRAFT COPOLYMERIZATION OF STYRENE ON CELLULOSE ACETATE BY AN IMMERSION TECHNIQUE. Hayakawa, Kiyoshi; Kawase, Kaoru (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 15: 383-90(Nov. 1966). (In Japanese).

Effects of radiation intensity, monomer concentration, and other factors on grafting were investigated for the graft copolymerization of styrene on the cellulose acetate fibres by an immersion technique. The initial rate of grafting was proportional to the 0.7th power of the intensity. When benzene was used as a solvent for the monomer, acceleration of the grafting rate as well as an increase in the molecular weight of grafted polystyrene were observed; while both the rate and the molecular weight were reduced when isopropylbenzene was used as a solvent. The results are discussed by considering the energy transfer and the chain transfer between the backbone polymer, the monomer, and the solvent, and also explained by comparing with the homopolymer formation. (NSA of Japan)

17693 IMPROVED METHODS FOR MANUFACTURING GRAFTED POLYESTERS. (to Japanese Association for Radiation Research on Polymers). British Patent 1,054,269. Jan. 11, 1967. Priority date June 29, 1962, Japan.

A method for the production of graft polymers of a polyester with vinyl or vinylidene monomers consists of carrying out the polymerization in the presence of a swelling agent for the polyester. Suitable swelling agents are one or more of an organic saturated acid; an organic saturated acid anhydride, salt, or ester; an organic acid; an inorganic acid salt; an alcohol free from ethylenic unsaturation; an organic halogen compound free from ethylenic unsaturation; dimethylformamide; dimethyl sulfoxide; formalin; acetonitrile; benzonitrile; adiponitrile; cyclohexylamine; xylene; acetophenone; acetone; methyl ethyl ketone; or acetaldehyde. The monomer may be used in the liquid or gaseous phase, and the polyester can be in any suitable form, e.g. powder, fiber, or film. Various methods may be employed to induce the grafting reaction, e.g. use of ionizing radiation, catalysts, or oxidation reduction reaction. (B.L.M.)

Cross-linking

3096 REACTIONS OF CROSSLINKING IN POLYSILOXANE CHAINS OF DIFFERENT STRUCTURE BY ACTION OF γ RADIATION. Poddubnyi, I. Ya.; Averyanov, S. V. Vysokomol. Soedin., 8: 1549-55(Sept. 1966). (In Russian).

The effects of the side-group type at the Si-atom and the presence and nature of hetero units in the main chain on the γ radiation vulcanization efficiency of both filled and unfilled siloxane rubbers were investigated. The relation between structure and heat resistance of polysiloxane was determined. A method for further increasing the heat resistance of polysiloxane rubber now can be recommended. Possible reaction mechanisms are discussed. (auth)

5972 METHOD FOR PRODUCING CROSSLINKED POLY-OLEFINS. Osawa, Toshikatsu (to Showa Electric Wire and Cable Co., Ltd.). Japanese Patent 1965-22198. Oct. 1, 1965. Filed Mar. 11, 1963.

A method for production of crosslinked polyolefins consists of mixing polyolefins with one or more of the compounds selected from aromatic conjugated quinones and/or their derivatives as aging retarders and then irradiating the mixture with ionizing radiation. The amount of the aging retarder is 0.02 to 4 parts by weight to 100 parts of the polyolefins. The resulting crosslinked polyolefins have good durability and are suitable as insulating materials for electric devices operating in the temperature range from 135 to 150°C. (NSA of Japan)

5971 METHOD FOR CROSSLINKING OLEFIN POLYMERS. Hiroasaburo (to Toyo Rayon Co., Ltd.). Japanese Patent 1965-21261. Sept. 21, 1965. Filed Aug. 28, 1962.

A method is proposed to improve the thermal properties of olefin polymers by crosslinking with ionizing radiation. Olefin polymers to be crosslinked are irradiated with ionizing radiation (and, if necessary, heated after irradiation) while in contact with one or more of the crosslinking accelerators selected from the group consisting of tetrachloroethane, trichloroethane, dichloroethane, chloroethane, tetrachloroethylene, trichloroethylene, and 1,2-dichloroethylene. The irradiation is carried out with a radiation dose of 0.2 to 100 Mrad at -50 to 300°C in an arbitrary atmosphere. (NSA of Japan)

12486 PROCESS FOR CROSS LINKING POLYMERS. (to Toyo Rayon Kabushiki Kaisha). British Patent 1,054,137. Jan. 4, 1967. Priority date Apr. 9, 1963, Japan.

A method is described for cross linking polymers of high molecular weight by subjecting them to irradiation by ionizing radiation and contacting them with acetylene before, during, or after the irradiation. The process is applicable to the following polymers: synthetic polyamide compounds, synthetic polyolefin compounds, synthetic polyvinyl compounds, and natural or synthetic polymers whose polymeric component is predominantly a diolefin having a conjugated double bond. (B.L.M.)

1404 METHOD FOR TREATMENT OF POLYMERS. Shino-hara, Yasuo; Yamaguchi, Kenji (to Toyo Rayon Co., Ltd.). Japanese Patent 1965-23342. Oct. 14, 1965. Filed Apr. 9, 1963.

A method is proposed for the crosslinking of polymers with only a few tenths of the radiation dose required in the simple radiation-crosslinking process. The polymers are irradiated with ionizing radiation in the presence of or in contact with acetylene, or the polymers are irradiated under any arbitrary atmosphere and then brought into contact with acetylene. (NSA of Japan)

4581 METHOD FOR PRODUCING A POLYVINYL CHLORIDE COMPOSITION. Suzuki, Fumio (to Sumitomo Electric Industries, Ltd.). Japanese Patent 1965-29019. Dec. 23, 1965. Filed Mar. 11, 1963.

A method is proposed for producing a composition having polyvinyl chloride component; an epoxy compound is added to polyvinyl chloride and then the mixture is crosslinked by ionizing radiation. Conventional irradiation methods for producing crosslinked polyvinyl chloride are as follows: use of an accelerating agent such as unsaturated (polyfunctional) compounds and sulfur compounds, irradiation of the polymer in water, immersion of the polymer in the solvent after irradiation, irradiation of the polymer in a special atmosphere (ammonia, nitrogen, or in vacuum), irradiation of the polymer in solvents, and heating of the polymer after irradiation. In the method proposed, various kinds of additives and a suitable amount of epoxy compound are added to polyvinyl chloride and then the mixture is irradiated; the resulting product is highly improved in its properties. The irradiation can be carried out very satisfactorily in the air. Vinyl chloride polymer gives the best result, but other copolymers may also be utilized similarly. (NSA of Japan)

Copolymerization

17683 RADIATION-INDUCED COPOLYMERIZATION OF CYCLOHEXENE AND SULFUR DIOXIDE. Ito, Masayuki; Kuri, Zenichiro (Univ. of Nagoya, Japan). Kogyo Kagaku Zasshi, 69: 538-41 (Mar. 1966). (In Japanese).

Mixtures of cyclohexene and sulfur dioxide were irradiated with γ radiation at +25 to -196°C. The ratio of cyclohexene to sulfur dioxide in copolymers produced by γ -irradiation was found to be close to unity, independent of temperature and the concentration of cyclohexene. The polymerization rate in the liquid phase is first order in dose rate and the addition of DPPH decreases the rate of polymer formation. In solid-phase polymerization, post polymerization takes place. Polymers obtained are soluble in dimethyl formamide and the intrinsic viscosity is 0.1 to 0.3. (NSA of Japan)

17682 RADIATION-INDUCED COPOLYMERIZATION OF PROPYLENE AND SULFUR DIOXIDE. Ito, Masayuki; Miyazima, Shoichi (Univ. of Nagoya, Japan). Kogyo Kagaku Zasshi, 69: 535-8 (Mar. 1966). (In Japanese).

Mixtures of propylene and sulfur dioxide were irradiated with γ radiation in the temperature range from 25 to -196°C. The ratio of propylene to sulfur dioxide in polysulfone produced by γ -irradiation was found to be close to unity, independent of temperature and the concentration of propylene. In liquid phase, the polymerization rate increased as the concentration of sulfur dioxide increased and was first order in dose rate. In solid phase, the polymerization rate was maximum when the concentration of propylene was about 50%, and post polymerization was observed in this phase. (NSA of Japan)

17681 RADIATION-INDUCED COPOLYMERIZATION OF ALLYLALCOHOL AND SULFUR DIOXIDE. Ito, Masayuki; Kuri, Zenichiro (Univ. of Nagoya, Japan). Kogyo Kagaku Zasshi, 69: 531-5 (Mar. 1966). (In Japanese).

Mixtures of allyl alcohol and sulfur dioxide were irradiated with γ rays at various temperatures between -78 and -196°C. The ratio of allyl alcohol to sulfur dioxide in copolymers produced by γ -irradiation was found to be close to unity, independent of temperature and the concentration of allyl alcohol. The polymerization rate in liquid phase is proportional to the square root of dose rate and the addition of DPPH inhibits copolymer formation. In solid phase polymerization, the conversion limit was observed and post polymerization takes place in this phase. The polymerization yield is decreased by irradiation of light after γ irradiation at -196°C. (NSA of Japan)

17671 COPOLYMERIZATION OF TRIOXANE BY γ -RADIATION. Roesinger, S.; Hermann, H.; Weissmehl, K. (Farbwerke Hoechst AG, Frankfurt am Main). J. Polym. Sci., Pt. A-1, 5: 183-92 (Jan. 1967). (In German).

High-molecular copolymers of trioxane with different cyclic ethers and formals were produced by γ radiation from a ^{60}Co source. It polymerized in the solid state at 53°C. Polymerization did not occur in the melt. Irradiation was carried out with exclusion of air at a dose rate of 7×10^5 RAD/hr. The polymerization rate increased considerably in the presence of 1,3-dioxolane and epichlorohydrin; the addition of other comonomers may reduce

the yield. The concentration of the comonomer was generally higher in the polymer than in the initial mix. These comonomers, which increase the polymerization rate, are introduced preferentially into the polymer chain; this is proved by the unstable polymer part and the thermal stability. Experiments with the trioxane-1,3-dioxolane system revealed that the unstable polymer part is markedly reduced and the heat stability considerably improved with rising concentrations of this monomer. The thermal stability and the reduced viscosity of these copolymers were within the range of technical processability. (auth)

110 RADIOCHEMICAL POLYMERIZATION OF ISOPRENE-METHYL METHACRYLATE MIXTURES. Hinschberger, Andre; Vacherot, Monique; Marchal, Jean (Centre de Recherches sur les Macromolecules, Strasbourg). Compt. Rend., Ser. C, 263: 620-3 (Aug. 29, 1966). (In French).

The radiochemical polymerization of isoprene-methyl methacrylate mixtures was studied at 25 and at -16°C. The coexistence of a cationic mechanism and a radical mechanism for the polymerization of isoprene during irradiation was confirmed. (tr-auth)

4579 METHOD FOR PRODUCING HEAT-STABLE POLYOXYMETHYLENE. Nomura, Sueichi (to Toyo Koatsu Industries, Inc.). Japanese Patent 1965-21356. Sept. 22, 1965. Filed Dec. 29, 1962.

A method is proposed for producing thermally stable polyoxymethylene by radioinduced copolymerization of tetraoxymethylene with isocyanate. Tetraoxymethylene or the tetramer of formaldehyde are irradiated in the presence of isocyanate compounds in the solid state with ionizing radiation. (NSA of Japan)

4577 METHOD FOR RADIATION-COPOLYMERIZATION OF FORMALDEHYDE AND ISOCYANIC ACID. Hamada, Michio (to Ube Industries Ltd.). Japanese Patent 1965-23800. Oct. 19, 1965. Filed Jan. 22, 1963.

In the proposed method for the copolymerization of formaldehyde and isocyanic acid, a copolymer with a high degree of polymerization was produced by irradiating a mixture of formaldehyde and isocyanic acid in the solid or liquid state at a temperature between -200 and 0°C. (NSA of Japan)

4580 METHOD FOR RADIATION-COPOLYMERIZATION OF ISOCYANIC ACID AND KETENE. Hamada, Michio (to Ube Industries Ltd.). Japanese Patent 1965-23799. Oct. 19, 1965. Filed Jan. 22, 1963.

In the method proposed for copolymerization of isocyanic acid and ketene, the copolymer with a high degree of polymerization is produced by irradiating a mixture of isocyanic acid and ketene, diluted with an appropriate solvent, in the solid or liquid state in the temperature range from -200 to 0°C with ionizing radiation. (NSA of Japan)

1400 METHOD FOR PRODUCING DIMETHYLKETENE COPOLYMERS BY IONIZING RADIATION. Tashiro, Shigeki (to Japanese Association for Radiation Research on Polymers). Japanese Patent 1965-22076. Sept. 30, 1965. Filed Sept. 6, 1962.

A method is proposed for the production of dimethylketene copolymers with aldehydes, ketones, cyclic ethers, esters of organic acids, or ethylenimine by irradiation. Dimethylketene is known to copolymerize with aldehydes, ketones, or esters of organic acids by the catalytic action of some metallic compounds, but no reports have yet been made on the copolymerization of dimethylketene with cyclic ethers or ethylenimine. By the method, aldehydes, ketones, cyclic ethers, esters of organic acids, or ethylenimine can be copolymerized with dimethylketene in the liquid or solid state below its boiling point, 34°C, by irradiation in the presence or absence of an inert solvent. (NSA of Japan)

19695 STUDIES ON RADIATION-INDUCED POLYMERIZATION OF α -OLEFINS. III. COPOLYMERIZATION OF α -OLEFINS WITH SULFUR DIOXIDE. Ueno, Katsuji; Shinkawa, Akihiro; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kyokai Nempo, 7: 71-4(1965-1966). (In Japanese).

The radioinduced copolymerizations of isobutene, 3-methyl-1-butene, and 4-methyl-1-pentene with sulfur dioxide were studied.

The rates of polymerization of these α -olefins and sulfur dioxide were high. All the polymers obtained were white powders and estimated to be an alternative copolymer of α -olefins and sulfur dioxide. From IR measurements of copolymers, isomerization rearrangement seems improbable. (auth)

14266 RADIATION INDUCED COPOLYMERIZATION OF BUTADIENE AND SULFUR DIOXIDE. Fujioaka, Syuji (Toyo Rayon Co., Ltd., Japan); Hayashi, Koichiro. Kogyo Kagaku Zasshi, 69: 330-4(Feb. 1966). (In Japanese).

Radio induced polymerization under the influence of γ rays from ^{60}Co of a mixture of butadiene and SO_2 was carried out and alternating copolymers were obtained. Observations of the UV spectra indicated the formation of a charge transfer complex of these monomers. The ceiling temperature of this polymerization was estimated to be at 70°C. The reaction proceeds through a radical mechanism. The microstructure of the butadiene unit in the copolymer consists of cis and trans-1,4 configuration, but no 1,2-configuration exists. (NSA of Japan)

14273 RADIATION INDUCED COPOLYMERIZATION OF ALLYL ACETATE AND SULFUR DIOXIDE, AND THERMAL DECOMPOSITION OF THE COPOLYMER OBTAINED. Fujioaka, Syuji (Toyo Rayon Co., Ltd., Japan); Hayashi, Koichiro. Kogyo Kagaku Zasshi, 69: 334-7(Feb. 1966). (In Japanese).

Allyl acetate, which is hardly homopolymerized because of the degradative chain transfer, is readily copolymerized alternatively with SO_2 under the influence of γ radiation. A charge-transfer complex of both compounds controls the propagating reaction. The rate constant and the activation energy of thermal decomposition were estimated for this copolymer both in air and in vacuum, and it was found that the decomposition mechanism is the so-called "Zipper-type" reaction. (NSA of Japan)

Ionic

8342 IONIC POLYMERIZATION UNDER ELECTRIC FIELDS. II. RADIATION-INDUCED POLYMERIZATION OF STYRENE. Sakurada, Ichiro; Ise, Norio; Kawabata, Seiji (Kyoto Univ.). Makromol. Chem., 97: 17-30(1966).

Cationic polymerization of p-methoxystyrene with iodine in ethylene dichloride was accelerated and the degree of polymerization increased by the presence of a strong electric field, but the radical polymerizations of styrene and methyl methacrylate were not affected. A comparison was made of types of polymerization with radioinduced polymerization in terms of the influence of electric field. Thus the ^{60}Co γ -radioinduced polymerization of styrene was carried out at -78°C in methylene chloride under a strong electric field. The rate of polymerization was enhanced in the presence of electric field whereas the degree of polymerization remained virtually unaffected. It was pointed out that the enhancement of the rate could be accounted for by the increase of ion yield due to the field, assuming a free-ion mechanism. The electric conductivity of the polymerizing solution could be attributed mainly to electrolyte produced by solvent radiolysis. In experiments with ethylbenzene and toluene instead of methylene chloride, which are believed to be fairly stable to the radiation, the conductivity of the solutions was measured. From the measurements, the average lifetime of ions supposedly originating from styrene molecules was estimated to be 10^{-1} to 10^{-2} sec; these ions are believed to be responsible for the radioinduced polymerization. (BBB)

119 STUDIES ON RADIATION-INDUCED IONIC POLYMERIZATION. II. EFFECT OF SOLVENT ON THE POLYMERIZATION OF ISOBUTENE AT LOW TEMPERATURE. Ueno, K.; Yamaoka, H.; Hayashi, K.; Okamura, S. (Kyoto Univ.). Int. J. Appl. Radiat. Isotop., 17: 595-602(Oct. 1966).

The radioinduced polymerization and co-polymerization of isobutene with styrene was studied in several solvents at -78°C. The rates of polymerization of isobutene in CH_2Cl_2 , CHCl_3 , and n-hexane had similar values, but in CS_2 a higher value was obtained. It was concluded that no relationship exists between the dielectric constant of solvents and the rate of polymerization. From the magnitude of the G-values (0.1 to 0.2) it was supposed that the growing chain is initiated by a free ion ($G = 0.1$ to 0.2). Monomer reactivity ratios in the polymerization of isobutene with styrene appeared to be similar to those obtained in the case of conventional cationic polymerization. The radioinduced polymerization rates for several monomers in CH_2Cl_2 at -78°C were found to lie in the following order: isobutene > styrene > p-methoxystyrene > isoprene $\approx$ α -methyl styrene > isobutyl vinyl ether > 2-chloroethyl vinyl ether > β -propiolactone. (auth)

19696 STUDIES ON RADIATION-INDUCED IONIC POLYMERIZATION OF STYRENE. V. FREE ION MECHANISM ON POLYMERIZATION OF STYRENE. Ueno, Katsuji; Williams, Ffranco; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 75-87(1965-1966). (In Japanese).

The radioinduced ionic polymerization of bulk styrene was studied under extremely dry conditions. It was found that the rate of polymerization, R_p , increased with more rigorous drying of the monomer. This effect was accompanied by a change in the exponent n for the dose-rate (I) dependence of R_p , from n values near unity to 0.6 ($R_p \propto I^{0.6}$). A mechanism involving biomolecular termination of free ions is thereby indicated. The strong retardation of the polymerization by scavengers of high proton affinity such as water, diethyl ether, ammonia, and trimethylamine in low concentrations (10^{-3} to 10^{-6}M) provided evidence that free cations are mainly responsible for the propagation. The addition of nitrous oxide did not affect R_p and did not appear to prevent electron capture by styrene. By kinetic analysis in $(\text{CN})_3\text{N}$ and stationary state ion concentration method k_p at 30°C was estimated to be in the range of from 10^7 to $10^8\text{M}^{-1}\text{sec}^{-1}$. Individual reaction steps for cationic and anionic mechanisms are discussed in detail, and the initiation is considered to occur through the respective monomeric ion radicals M^+ and M^- . It was concluded that the predominance of cationic over anionic polymerization is due to faster initiation and/or propagation processes in the former case. (auth)

5921 RADICAL INDUCED CATIONIC POLYMERIZATION. Okamura, S.; Takakura, K.; Hayashi, K. (Kyoto Univ.). Pure Appl. Chem., 12: 387-401(1966).

Results are reported for a comparison of the benzoyl peroxide induced cationic polymerization with the gamma and ultraviolet radioinduced polymerization of cyclic esters and ethers with or without various additives. Studies were made using β -propiolactone, diketene, 3,3-bis(chloromethyl)oxetane, trioxane, and tetroxane. A reaction mechanism is proposed for the free radical induced cationic polymerization. (J.G.B.)

15953 ANIONIC POLYMERIZATION OF ACRYLONITRILE INITIATED BY GAMMA RAYS IN THE VICINITY OF ITS VITREOUS TRANSITION POINT. Chapiro, Adolphe; Perek, Liliana (CNRS, Bellevue, France). Compt. Rend., Ser. C, 264: 285-7 (Jan. 16, 1967). (In French).

Mixtures of acrylonitrile and dimethylformamide form a glass at low temperatures for proportions of monomer between 25 and 60%. The irradiation of these mixtures at -196°C leads, after fusion under vacuum, to an important quantity of polymer. This polymerization, which is inhibited by acetone, methanol, and water, seems to proceed by an anionic mechanism. If the fusion of the irradiated mixture is effected in the presence of acetone, it does not form the polymer. From irradiations effected at different temperatures it was shown that polymerization is produced only in a very narrow temperature range on both sides of the vitreous transition. (tr-auth)

17680 EFFECT OF ADDITIVES ON THE RADIATION-INDUCED POLYMERIZATION OF TRIOXANE. Naruse, Tsutomu; Haga, Mikio (Univ. of Nagoya, Japan). *Kogyo Kagaku Zasshi*, 69: 527-30(Mar. 1966). (In Japanese).

Effects of electron or proton acceptors, as additives on an ionic polymerization process considered to take part in the radio-induced solid-state polymerization of trioxane, were investigated. The rate of polymerization increased in the presence of electron acceptors and decreased markedly in the presence of proton acceptors. These results indicated the participation of a cationic mechanism. The free ion yield (G_0) in trioxane was estimated to be about 1.3 by applying the Mayo-Overberger relation to results obtained in the presence of ammonia. (NSA of Japan)

Solvents

103 RADIATION POLYMERIZATION OF ETHYLENE IN ORGANIC SOLVENTS. I. EFFECTS OF CARBON TETRACHLORIDE ON POLYMERIZATION. Yamabe, Masamori (Mitsubishi Petrochemical Co., Ltd.); Shimizu, Harumichi, Yuki Gosei Kagaku Kyokai Shi, 24: 659-64 (Aug. 1966). (In Japanese).

Under ethylene pressure of 30 kg/cm², radiation polymerization of ethylene was conducted in an autoclave using cyclohexane containing a small amount of carbon tetrachloride as a solvent. The reaction mixture was exposed to the γ rays from cobalt-60 at a rate of 0.121 MRAD/hr and total irradiation of 0.24-6.06 MRAD at 20°C. Polymerization was found to proceed, in a stepwise manner, to form telomer, liquid products, and ultimately solid products. The reaction was accelerated in the presence of carbon tetrachloride, the mean molecular weight of the product being decreased at the same time. As in the case of the ethylene-carbon tetrachloride telomerization reaction, the products of this study probably contain four chlorine atoms per one polymeric molecule. (NSA of Japan)

102 RADIATION POLYMERIZATION OF ETHYLENE IN ORGANIC SOLVENTS. 2. INFRARED ABSORPTION SPECTRA AND MELTING ENDOTHERMIC CURVES OF THE PRODUCTS. Yamabe, Masamori (Mitsubishi Petrochemical Co., Ltd., Japan); Shimizu, Harumichi, Yuki Gosei Kagaku Kyokai Shi, 24: 665-71(Aug. 1966). (In Japanese).

Liquid as well as solid polymeric products are obtained by radiation polymerization of ethylene in cyclohexane containing carbon tetrachloride. The infrared absorption spectra indicate that the liquid product is structurally similar to the telomer and its -C-C- chain is rather extended. The solid product begins to show the properties of polyethylene as the polymerization reaction progresses. In this reaction, the telomer first formed probably grows into solid product through liquid intermediate. The solid product consists of three types of components of varying melting points. The component of relatively low melting point resembles the liquid product, and it would probably change into the components with higher melting point as the reaction progresses. It is evident that some structural changes also take place as the molecular weight increases. (NSA of Japan)

4548 RADIOCHEMICAL POLYMERIZATION AND COPOLYMERIZATION OF METHYL METHACRYLATE IN VITREOUS STATE. Chapiro, Adolphe; Nakashio, Seizo (CNRS, Bellevue, France). *J. Chim. Phys.*, 63: 1031-6(July-Aug. 1966). (In French).

The radioinduced polymerization of methyl methacrylate in dilute solutions in mineral oil was investigated at temperatures ranging from -63 to -196°C. A study of the structure of these mixtures showed that the monomer was dispersed in small droplets in the vitreous oil phase. The polymerization proceeds in these droplets which remain in a supercooled state down to -130° and form a glass below this temperature. The copolymerization with styrene was also examined under such conditions. An interpretation of all these results is given which emphasizes the phase separation occurring in organic glasses at low temperatures. (auth)

Solid State

15954 INVESTIGATION IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XV. THE COPOLYMERIZATION OF VINYL CHLOROACETATE AND VINYL LAURATE. Hardy, Gyula; Boros-Gyevi, Edith (Research Inst. for the Plastics, Budapest). *Acta Chim. Acad. Sci. Hung.*, 50: 319-24(1966).

The gamma-induced liquid-phase copolymerization of vinyl chloroacetate and vinyl laurate was characterized by the values $r_1 = 0.87$ and $r_2 = 0.65$. In the solid state the two components crystallized separately and one after the other. In the solid state, polymerization rate was highest for pure vinyl chloroacetate. In a mixture containing only a small quantity of vinyl laurate the rate of copolymerization in a thoroughly supercooled liquid phase was twice as high as in the solid state. (auth)

5957 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XVI. COPOLYMERIZATION IN EUTECTIC MIXTURES OF MONOMER PAIRS NON POLYMERIZABLE IN THE SOLID STATE. (COPOLYMERIZATION OF MALEIC ANHYDRIDE AND MONOPROPYL ENDO-METHYLENE-TETRAHYDROPHthalate). Hardy, Gyula; Fedorova, Natalia; Nyitrai, Karoly (Mueanyagipari Kutató Intézet, Budapest). *Magyar Kem. Foly.*, 72: 461-3(Oct. 1966). (in Hungarian).

The kinetics of the solid state copolymerization of maleic anhydride and monopropylendo-methylene-tetrahydrophthalate was investigated in eutectics mixture and in other compositions. It was found that monomers which do not polymerize in the solid state can be copolymerized in monomer pairs, owing to the increased mobility of the monomeric molecules over the adjacent crystal surfaces. Copolymerization takes place in the surface layer only. The composition of the obtained copolymers also supports this fact. (auth)

12451 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. XVII. POLYMERIZATION AND COPOLYMERIZATION OF 5-CARBOXY-BICYCLO-[2.2.1]-HEPTENE-(2) WITH MALEIC ANHYDRIDE. Hardy, Gyula; Nyitrai, Karoly; Sarlo, Csaba (Mueanyagipari Kutató Intézet, Budapest). *Magyar Kem. Foly.*, 72: 517-22(Dec. 1966). (In Hungarian).

Radioinduced liquid and solid state polymerization of 5-carboxy-bicyclo-[2.2.1]heptene-(2) and the copolymerization reactions with maleic anhydride have been investigated and the structures of the polymers studied. The kinetics of the polymerization and copolymerization processes have linear character, and the rate of the solid state polymerization indicates a maximum value at 80°, 10° below the melting point, where a second order transition point exists. There is a eutectic composition in the two-component solid system; the rate of the copolymerization changes accordingly, and the composition of the obtained copolymers indicate a very high rate of self-addition of maleic anhydride. (auth)

12450 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. XVIII. INVESTIGATION OF THE MONOALLYL ESTER OF NORBORNENEDICARBOXYLIC ACID AND ITS TWO-COMPONENT SYSTEMS. Hardy, Gyula; Nyitrai, Karoly (Mueanyagipari Kutató Intézet, Budapest). *Magyar Kem. Foly.*, 72: 522-5(Dec. 1966). (In Hungarian).

The solid state polymerization of norbornenedicarboxylic monoallyl ester has been investigated. The polymerization proceeds by the reaction of the allylic bonds up to 20% conversion; above this limit an insoluble polymer is obtained as a result of the reaction of the double bonds of the ring. The two-component system of norbornenedicarboxylic monoallyl and monopropyl ester exists as an isomorphous solid solution. The propyl ester acts as a physical barrier in the solid state polymerization of the allyl ester and increasing the concentration of the propyl ester results in a monotonous decrease of the rate of polymerization. The two-component systems of monoallyl ester with acetanilide, succinimide, and naphthalene are characterized by the formation of eutectic compositions. The characteristics of the solid state polymerization in these two-component systems indicate the formation of quasi-eutectic structures, i.e., the physical structures of these solid systems depend very much on the conditions of cooling and crystallization. (auth)

17665 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XIX. SOLID STATE POLYMERIZATION OF TWO-COMPONENT SYSTEMS. Hardy, Gyula; Varga, Jozsef; Nagy, Gabor; Varga, Eszter; Sara, Laszlo. Magyar Kem. Foly., 73: 43-7 (Jan. 1967). (In Hungarian).

The influence of benzoquinone was investigated in the solid-state polymerization of acrylamide, trioxane, and 3,3'-bis-chloromethyloxetane. The solid-state polymerization of trioxane in the presence of succinimide and naphthalene was studied. These two-component systems were characterized by the formation of simple eutectics. A comparison of the effect of benzoquinone and inert added compounds showed that the solid-state polymerization of acrylamide had radical mechanism; in the case of trioxane and 3,3'-bis-chloromethyloxetane the mechanism of the polymerization cannot be decided by the use of benzoquinone. Investigation of the system trioxane-naphthalene called attention to the important role of the conditions of crystallization in the polymerization to two-component systems. (auth)

8372 RADIOPOLYMERIZATION OF SOLID ACRYLONITRILE: EFFECT OF THE CRYSTALLIZATION CONDITIONS AND PHASE TRANSITIONS. Bensasson, R.; Dworkin, A.; Marx, R. (Faculte des Sciences, Orsay, France). pp 87-101 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The specific heat of solid acrylonitrile was studied between -196 and -83°C after solidification by different methods. The influence of the conditions of crystallization and of phase transition on the polymer yield and the heat evolution after irradiation of this polymer in the solid state was examined. It was shown that the phase transitions explain the kinetic and calorimetric results. (tr-auth)

8375 RADIOCHEMICAL COPOLYMERIZATION IN THE SOLID PHASE. Chapiro, Adolphe; Jendrychowska-Bonamour, Anna-Maria; Roussel, Daniel (CNRS, Bellevue, France). pp 119-22 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The copolymerization of styrene with methyl methacrylate and acrylonitrile was studied at -78°C in the solid phase by initiating the reaction with γ rays. The kinetics of these reactions and the composition of the copolymers lead to the conclusion that these copolymerizations proceed by a radical mechanism and the termination reactions are very strongly retarded. (tr-auth)

5923 RADIATION POLYMERIZATION IN THE SOLID PHASE WITH BREAKING OF THE RING. Scrivener, J. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 62, Suppl., 6-12 (Nov.-Dec. 1966). (In French).

Solid-phase radiation polymerization with breaking of the ring in heterocyclic compounds is discussed. The principal results obtained on a world-wide basis are reviewed. The mechanism of the radiation polymerization is illustrated on trioxane. (J.S.R.)

15964 POLYMERIZATION IN THE SOLID STATE INITIATED BY RADIATIONS. Chapiro, Adolphe (CNRS, Bellevue, France). pp 187-312 of Actions Chimiques et Biologiques des Radiations. Haissinsky, M. Paris, Masson et Cie Editeurs, 1966. (In French).

General characteristics of polymerization in the solid phase were examined by clearing away the different factors that seem to intervene in one or several stages of the reaction. The particular objects of extensive experimental studies were then examined in detail. These are the vinyl monomers, heterocyclic monomers, and monomers with carbonyl and nitrile functions. The different aspects of these reactions, which can contribute to radiation chemistry, are emphasized. (J.S.R.)

8376 RADIOCHEMICAL POLYMERIZATION OF SOME VINYLIC COMPOUNDS IN SOLID MIXTURES WITH PARAFFIN OIL. Chapiro, Adolphe; Pertessis, Maria (CNRS, Bellevue, France). pp 123-30 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The radiochemical polymerization of methyl methacrylate (MMA), methyl acrylate (MA), vinyl acetate (VA), and styrene (ST) in solid mixtures with paraffin oil was studied at -78°C. In the case of MMA the reaction was very fast. The conversion curve had a long linear portion whose slope was maximum for mixtures containing 10% of the monomer. The molecular weights

of the polymer obtained followed an analogous law. The reaction was inhibited by oxygen and by other free radical interceptors, which suggests that the polymerization proceeds by a radical mechanism. From the velocities and the molecular weights, the radiochemical yields of radicals that effectively initiated polymerization chains were calculated. This yield was a maximum for a concentration of 15% MMA in the solid mixture; for this concentration $G(R) = 1.44$. These yields were compared with values deduced from electron paramagnetic resonance measurements in the same mixtures. The three other monomers examined had kinetic characteristics analogous to those obtained for MMA, that is, the polymerization velocity was maximum for very low concentrations of the monomer in the mixture. However, the reaction was much slower in these systems. The role played by paraffin oil in these reactions is discussed in the light of these results. (tr-auth)

5970 METHOD FOR PRODUCTION OF PERFLUORO-OLEFIN POLYMERS. Yonetani, Yutaka (to Daikin Kogyo Co., Ltd.). Japanese Patent 1965-23352. Oct. 14, 1965. Filed Feb. 21, 1963.

In the method proposed for producing perfluoro-olefin polymers, perfluoro-olefins having at least three carbon atoms and at least one double bond were irradiated in the solid state at low temperature below the melting point with high-energy ionizing radiation. (NSA of Japan)

8387 RECTIFICATION ON THE APPARENT EFFECT OF AN ELECTRIC FIELD ON THE RADIOPOLYMERIZATION OF SOLID ACRYLONITRILE. Chapiro, Adolphe; Inoue, Miyako (CNRS, Bellevue, France). pp 73-5 of Applications des Rayonnements en France. Vol. II. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Experiments showed that modification of the kinetic characters of the polymerization of solid acrylonitrile observed previously when the irradiation cell was electrically grounded was due to an increase in the sample temperature. The presence of the electric wire under the cell introduced an air layer, which isolated the cell of the cryostat and resulted in elevation of the temperature at which acrylonitrile undergoes a structure transformation. It is this that is responsible for the modification of the characters of the polymerization. (tr-auth)

128 METHOD FOR PRODUCTION OF IMPROVED POLYOXYMETHYLENES. Miyazaki, Kagayaki (to Asahi Chemical Industry Co., Ltd.). Japanese Patent 1965-21278. Sept. 21, 1965. Filed Oct. 25, 1962.

A method is proposed for the production of polyoxymethylenes with improved properties. Polyoxymethylene of high molecular weight has good thermal stability and is a valuable material for fabrication of various articles. By the method proposed improved polymers of high molecular weight and excellent thermal stability can be obtained. The polyoxymethylene structure is the main component of the polymer chains. The polymers, which are constructed by the mixture of oxymethylene polymer, polymers of unsaturated acid amides including their derivatives and homologues, and copolymers of oxymethylene and acid amides, are produced by the solid state radioinduced polymerization of trioxane and unsaturated acid amides with ionizing radiation. (NSA of Japan)

12482 METHOD FOR PRODUCING STEREOSPECIFIC POLYACRYLONITRILE BY IONIZING RADIATION. Sobue, Hiroshi. Japanese Patent 1966-1552. Feb. 4, 1966. Filed May 1, 1963.

A method is proposed for producing isotactic polyacrylonitrile of stereospecific structure by low-temperature solid-state irradiation polymerization of acrylonitrile monomers admixed with one or any combination of the following compounds: nitrile compounds, acetone derivatives, alcohols, benzene derivatives, or metal oxides. Ionizing radiation is used for the irradiation. (NSA of Japan)

8388 KINETIC CHARACTERISTICS OF THE RADIOCHEMICAL POLYMERIZATION OF CRYSTALLIZED ACRYLAMIDE. Chapiro, Adolphe; Zumer, Maxime (CNRS, Bellevue, France). pp 77-80 of Applications des Rayonnements en France. Vol. II. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The radiochemical polymerization of acrylamide at 20°C was studied in a wide range of γ intensities. Autoaccelerated conversion curves were obtained. The instantaneous velocity verified the relation $V_{\text{inst.}} = Kt^{0.8}$. Experiments with monomer crystals of different qualities showed that this parameter had only a slight influence on the reaction velocity. The molecular masses of the polymers formed increased with conversion. For a given conversion they were smaller when the radiation intensity was highest. The molecular masses were much larger when the monomer crystals were fused and recrystallized by fast tempering before irradiation. The initiation radiolytic yield G (initiator centers) was calculated from the velocities and molecular masses. This yield varied from 1.0 to 2.5. It was larger when the intensity was small. (tr-auth)

5913 POLYMERIZATION IN THE SOLID STATE. Bamford, C. H.; Eastmond, G. C. (Univ. of Liverpool). Rep. Progr. Appl. Chem., 50: 472-9 (1965).

Recent developments are reviewed under the following headings: introduction, molecular mobility, effects of stress, and topotactic polymerisation. Attention is given to work on irradiation polymerisation. (UK)

Liquid State

1401 METHOD FOR PRODUCING DIMETHYLKETENE POLYMER BY IONIZING RADIATION. Tashiro, Shigeki (to Japanese Association for Radiation Research on Polymers). Japanese Patent 1965-22075. Sept. 30, 1965. Filed Sept. 8, 1962.

A method is proposed for producing dimethylketene polymer by radioinduced polymerization of the monomer in the liquid or solid state below its boiling point, 34°C, without use of metallic compounds. The irradiation can be carried out either in the presence or absence of an inert solvent. (NSA of Japan)

10401 RADIATION-INDUCED LIQUID STATE POLYMERIZATION OF SOME CYCLIC ETHERS. Penczek, St.; Wieteska, J.; Kubisa, P. (Research Inst. of Plastics, Warsaw). Makromol. Chem., 97: 225-31 (1966).

Attempts were made to use ionizing radiation to induce polymerization of 14 cyclic ethers. Cyclohexene α -oxide was polymerized in the liquid state under the influence of ^{60}Co γ radiation at room temperature. Several other oxiranes (including glycidyl ethers) and oxetanes were investigated under the same conditions, but only cyclohexene α -oxide gave fairly high yields and rates of polymerization at the dose rate used (2.21×10^5 R/hr). According to the IR spectra, the polymer did not contain carbonyl groups and had an identical spectra to that of the cationically polymerized product (BF_3 in CH_2Cl_2 solution at -78°C). Since cyclohexene α -oxide itself is very reactive toward cationic catalysts and rather stable in the presence of even strong bases, a cationic mechanism of radioinduced polymerization is likely. This mode of H-abstraction is discussed. α -Hydrogen abstraction in cyclohexene oxide under the action of *tert*-butyl peroxide predominates over β -abstraction. The next step should be the attack of the radical on the monomer molecule and the competing reaction of rearrangement giving the corresponding ketone. This radical should also participate in the initiation and/or chain termination reactions if a radical process is involved. However, no carbonyl groups are present in the formed polymer, confirming a nonradical mechanism of polymerization. (BBB)

5935 STRUCTURE OF POLYVINYLIDENEFLUORIDE OBTAINED BY RADIATION AND CHEMICAL POLYMERIZATION. Galperin, E. L.; Dubov, S. S.; Volkova, E. V.; Mlenik, M. P.; Bulygina, L. A. Vysokomol. Soedin., 8: 2033 (Nov. 1966). (In Russian).

A comparison was made of polyvinylidene fluoride obtained by radioinduced polymerization in the gaseous phase in which the α -form (cis-conformation) occurs and chemical polymerization in which mainly the β -form (o-trans-conformation) occurs. (auth)

3121 VAPOR-PHASE POLYMERIZATION OF ETHYLENE BY HIGH-ENERGY RADIATION. Sawayanagi, Shoichi; Hinaji, Chuhei (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 12: No. 2, 49-54 (Feb. 1966). (In Japanese).

A description is given of vapor-phase polymerization of ethylene by high-energy radiation. The polymerization facilities in the authors' laboratory, with 300,000 Ci of ^{60}Co as the radiation source, are outlined; a flow diagram of their polymerization apparatus is also given. Some of the properties of radiation-polymerized polyethylene are: molecular weight M_v , 1.5 to 30×10^4 ; density d^{25} , 0.925 to 0.945; melting point, 112 to 125°C; degree of branching $\text{CH}_3/1000$ C, 0 to 10; degree of crystallization, 65 to 85%; melt indices MI and HMI, 105 and 2.2; and M_w/M_n value, 1.5 to 4. (NSA of Japan)

1406 METHOD FOR POLYMERIZING TETRAFLUOROETHYLENE CONTINUOUSLY IN GAS PHASE. Yamada, Akira (to Daikin Kogyo Co., Ltd.). Japanese Patent 1965-22078. Sept. 30, 1965. Filed Nov. 13, 1962.

The circulating system employs a cyclone type polymerization reaction apparatus in which the tetrafluoroethylene monomer liquefied above 50% or supercooled is irradiated with electrons or other radiation beams at radiation doses below 1.0×10^4 R. The polymerization temperature is controlled by its latent heat of vaporization, and the heating coefficient of the apparatus is increased by means of the cyclone flow of circulated tetrafluoroethylene monomer, thereby accelerating the reaction rate. The resulting polymer is taken out of the system continuously to prevent the excessive irradiation. At the same time the unreacted monomer is removed and passed through a cooling device, if necessary, to remove the reaction heat. New monomer is added to the cooled monomer, liquefied above 50% or supercooled, and the mixture is sent into the reaction apparatus. Damage to the physical properties of the produced tetrafluoroethylene due to excessive radiation is avoided by this procedure. (NSA of Japan)

Foamed Bodies

5968 METHOD FOR PRODUCING FOAMED BODIES OF POLYMERS OF ETHYLENE HOMOLOGUES. Sagane, Norio; Iida, Masahiro (to Sekisui Chemical Co., Ltd.). Japanese Patent 1965-25072. Nov. 1, 1965. Filed Oct. 29, 1962.

A method is proposed for the production of highly foamed bodies, in which mixtures of the polymers of ethylene homologs irradiated with ionizing radiation and foaming agents evolving gases by thermal decomposition are melted by heating above 120°C and then kept under pressure below 200 mmHg to give the foamed bodies. (TSS)

1405 METHOD FOR PRODUCING FOAMED BODIES OF SYNTHETIC RESINS. Kanai, Masanori (to Sekisui Chemical

Co., Ltd.). Japanese Patent 1965-24388. Oct. 25, 1965. Filed Feb. 15, 1963.

A method for producing foamed bodies of synthetic resins with excellent thermal stability and high mechanical strength includes the following steps: (1) mixing of one or more of the monomers selected from the group consisting of acrylamide, methacrylamide, acrylic acid, and methacrylic acid, a thermally decomposed foaming agent, a mineral acid of high acidity, and any monomer, if necessary, copolymerizable with the monomers mentioned; (2) polymerization of the mixture to give the thermoplastic body containing the foaming agent homogeneously, and (3) heating the plastic body to a temperature above the softening point of the plastic in order to give simultaneously the foaming and the crosslinking reaction between the polymer molecules. The various polymerization methods such as polymerization with catalysts or initiators, thermal polymerization, radioinduced polymerization, photopolymerization with ultraviolet or visible lights, and ultrasonic polymerization are applicable to the method; however the radioinduced polymerization or the catalytic polymerization followed by irradiation gives the best results. (NSA of Japan)

17692 METHOD FOR PRODUCING FOAMED POLYOLEFINE. Takahashi, Toshimasa (to Toyo Rayon Co., Ltd.). Japanese Patent 1965-29187. Dec. 24, 1965. Filed Aug. 9, 1963.

A method is proposed for producing a material of cellular polyolefin plastics. Polyoxymethylene resin (1 to 10 wt %) and polyolefin resin are mixed together, melted, and irradiated with 1 to 20 MRAD of ionizing radiation. Polyoxymethylene resin is stable in the dispersed state, producing no foams, but on irradiating it is degraded to polyoxymethylene having low molecular weight, and on heating decomposes to formaldehyde gas. This decomposition does not take place all at once as in usual foams, but under constant temperature it occurs gradually. Thus, not only the gas evolution can be controlled by the temperature, but the foam-producing rate can be controlled by both the radiation dose and temperature, leading to good foamed bodies. The irradiation dose is chosen to prevent decomposition of the cellular foams by suitable crosslinking but not to prevent the necessary flow of polymer in foaming by the crosslinking. (NSA)

Porous Materials

12483 MICRO-POROUS POLYETHYLENE AND A PROCESS FOR THE MANUFACTURE THEREOF. (to W. R. Grace and Co.). British Patent 1,051,320. Dec. 14, 1966. Priority date Jan. 13, 1964, United States.

Shaped articles of microporous crosslinked polyethylene are formed by mixing normally solid polyethylene and 20 to 400 wt % of a pore-forming solid with a particle diameter of 0.1 to 10 μ , shaping the mixture into the desired shape at a temperature at least sufficient to melt the polyethylene, crosslinking the polyethylene by irradiation with ionizing radiation, and then removing the pore-forming solid at a temperature below the degradation temperature of the crosslinked polyethylene. Crosslinking may be accomplished by adding 0.1 to 10 wt % of an organic compound capable of generating free radicals or by irradiation with ionizing radiation. (B.L.M.)

130 METHOD FOR PRODUCING CATION-EXCHANGE MEMBRANES. Nagaoka, Haruo (Inst. of Physical and Chemical Research). Japanese Patent 1965-21157. Sept. 20, 1965. Filed Apr. 12, 1962.

A method is proposed for producing cation-exchange membranes. Vinyl acetate is graft polymerized with powders or films of synthetic resins by irradiating them with ionizing radiation in contact with the monomer vapor. In the case of powders, they are fabricated into films after grafting. The vinyl acetate-grafted films are treated by deacetylation of the acetate group in the grafts, followed by esterification of the hydroxyl group thus formed by sulfuric acid, etc. to introduce ion-exchange groups into the polymer structure. By the method, which is industrially applicable, strongly acidic cation-exchange membranes with excellent electrochemical properties and high mechanical strength can be obtained. (NSA of Japan)

Wood Polymers

10399 IRRADIATED WOOD PLASTIC MATERIALS TECHNOLOGY. Harmison, Lowell T. *Energ. Nucl.* (Paris), 8: 307-9 (July-Aug. 1966).

The development and testing of plastic-wood composite materials, the kinds of wood, the monomers, the impregnation processes, the radiation sources that can be used, and the nature of the products obtained are discussed. Their fields of application and the commercial market open to them are considered. (auth)

15940 RADIO-CHEMICAL EFFECTS IN THE WOOD-PULP-MONOMER SYSTEM. Varga, Stefan; Kosik, Martin (Slovak Polytechnic Inst., Bratislava). *Jad. Energ.*, 13: 62-9 (Feb. 1967). (In Czech).

Modification of wood pulp by radioinduced polymerization is discussed. Radiation effects on cellulose, lignine, and wood pulp are described. It is shown that the initial radioinduced combination of wood pulp and vinyl monomers is based on the properties of the polymer and basic monomer components and can be further induced by irradiation of the impregnated pulp. An analysis of the chemistry of wood-pulp polymerization is given and the physico-chemical and mechanical properties of the irradiated wood pulp-polymer system are described. (tr-auth)

10377 (SGAE-CH-39/1966) STRAHLUNGS-AUSGEHAERTETE HOLZ-KUNSTSTOFF-KOMBINATIONEN (HKK). (Radiation-Tempered Wood-Plastic Combinations (HKK)). Guetlbauer, F.; Proksch, E.; Bildstein, H.; Slais, E. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Chemie). 1966. 41p. (In German). Dep. mn.

By impregnation of wood with various vinyl polymers and concurrent hardening with energetic radiation, products were obtained that combine the properties of the initial components advantageously. They preserve the esthetic appearance of wood but show much higher resistance properties as well as increased water stability. The preparation methods, properties, cost, and application possibilities were described. (tr-auth)

8534 RADIATION-HARDENED WOOD-PLASTIC COMBINATIONS. Guetlbauer, F.; Proksch, E.; Bildstein, H. (Institut fuer Chemie, Reaktorzentrum, Seibersdorf, Austria). *Oesterr. Chem.-Ziet.*, 67: 349-61 (1966). (In German).

Products obtained by impregnation of wood with various vinyl monomers and subsequent polymerization with high-energy radiation have the aesthetic appearance of wood as well as greater strength and water resistivity. Methods of preparation, properties, costs, and possible uses are described. Fifteen types of wood are suggested for use, and the relation of the monomers vinyl chloride, methyl methacrylate, vinyl acetate, and styrene-acrylonitrile to the preparation of combinations from 11 of these is tabulated. Typical doses for complete polymerization in an inert gas for 7 combinations of wood and monomer are given, together with description of sources and activators. Industrial layouts are reviewed briefly, and hardness, strength, and special properties of the products are described. Use of the materials for construction elements, furniture, sports equipment, and other applications is outlined. New results for a spruce wood-methyl methacrylate combination are given; % polymerization, hardness, and strength are shown graphically as functions of the dose. (BBB)

235 (PAEC/CHEM-101) GRAFT COPOLYMERIZATION ON WOOD PINUS LONGIFOLIAS USING ^{60}Co GAMMA RAYS. Awan, M. H.; Husain, Ather (Atomic Energy Centre, Lahore (Pakistan). Chemistry Div.). Oct. 16, 1965. 56p.

Wood pieces from *Pinus Roxburghii* (*Pinus Longifolias*) were subjected to graft copolymerization with styrene, methylmethacrylate and acrylonitrile. The grafted samples were found to be more resistant to the attack of *Aspergillus niger*. Placed in moist soil in the open for about eight months, these pieces showed no growth of fungi. Water repellent properties were increased during grafting. The effect of irradiation on the dimensional stability and wood working quality of the wood samples is discussed. Various methods of graft copolymerization, as well as the tests carried out on the grafted samples, are described. (auth)

19708 RADIATION CHEMISTRY AND RADIATION DAMAGE. Aagaard, P.; Christensen, H.; Nilsson, G. (Aktiebolaget Atomenergi, Stockholm). *Svensk Kem. Tidskr.*, 79: No. 2, 122-30 (1967). (In Swedish).

Wood-plastic combinations were made by radioinduced polymerization. The properties of the products were investigated. The radiolytic formation of phenol in the benzene-water system are considered. The decomposition of hexane adsorbed on silica gel was studied by means of gas chromatography and ESR spectroscopy. Pulse radiolysis technique was used for determination of the spectrum of the OH-radicals in water, and to find the spectrum of solvated electrons in ice. The radiation damage of uranium metal and uranium dioxide was studied. The number of uranium atoms sputtered per emitted fission fragment is reported. (INIS-Sweden)

3106 SOLVENT EFFECTS UPON RADIATION-INDUCED GRAFT COPOLYMERIZATION OF STYRENE ONTO LIGNIN. Koshijima, Tetsuo; Muraki, Einosuke (Goverment Industrial Research Inst., Osaka). *Nippon Mokuzai Gakkaishi*, 12: 139-44 (June 1966). (In Japanese).

Gamma radioinduced (^{60}Co) graft copolymerization of styrene onto hydrochloric acid-treated pine (*Pinus densiflora*) lignin, previously methylated with diazomethane, was carried out with addition of methanol, ethanol, 2-propanol, 1-butanol, n-hexane, and benzene to the lignin-styrene (1:10) system, in order to get homogeneous and highly grafted copolymer. It was found that methanol markedly accelerates the grafting but benzene does not.

Two percent of methanol with styrene monomers gave rise to a maximum grafting ratio of 430%, which diminished rapidly with increasing concentrations of methanol. With both n-hexane and benzene, greater amounts of styrene monomers polymerized to polystyrene homopolymer in comparison with results of polystyrene being grafted onto lignin molecules. Alternatively, 40% of styrene monomers grafted onto lignin and only 17% was converted to its homopolymer by addition of 2% methanol. The facts that the optimum methanol concentration is very low (2%), the degree of the solvent effects depends upon the G values, and styrene monomers graft onto molecules selectively by addition of methanol, suggest that the effects of methanol upon lignin-styrene graft copolymerization occur by radicals subsequently produced by radiolysis of added methanol. Either both or one of the two radicals $\text{H}\cdot$ and $\text{CH}_3\text{OH}\cdot$, which predominate among the radicals arising from methanol, probably act to increase active centers in lignin molecules. Experiments on the solvent effects of methanol, ethanol, 2-propanol, and 1-butanol support this deduction. Initial graft copolymerization velocities of the lignin-styrene-methanol system were proportional to the square root of the dose rate used. This graft copolymerization was inhibited completely by addition of hydroquinone. These findings indicate that graft copolymerization progresses by radical reaction. When an ether-dioxane-water mixture was used, instead of ether as solvent in diazomethane-methylation of lignin, grafting rates of resultant graft copolymers increased appreciably in lignin-styrene-benzene and lignin-styrene systems, independently of the methoxyl contents of original lignins. (BBB)

Vulcanization

9259 SOME IMPORTANT FACTORS IN THE RADIATION TREATMENT OF NATURAL RUBBER LATEX. Lamm, A.; Lamm, G. (Center of Nuclear Research, Saclay, France. Lab. of Rubber Control and Research, Paris). pp 139-47 of *Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966.*

It was shown previously that γ irradiation of natural rubber latex and of aqueous carbon black dispersions followed by mixing of the irradiated products and by their drying yields excellent rubbers. Various factors that could affect the properties of rubber obtained by this technique were investigated. The effect of chloroform on the mechanical properties of latex reinforced by carbon black was studied, and it was shown that the dose for maximum tensile strength is diminished of a factor of about 10 when the chloroform is present. Black latex films prepared without sensitizer from irradiated latex and carbon black were aged in an accelerated test. The aging properties of the irradiated films were excellent. A study of the electric conductivity showed that irradiation of the carbon black caused an increase in the conductivity and that irradiation of the latex caused a drastic increase in the conductivity. The use of colloidal silica as a reinforcement agent in irradiated latex was studied and compared with the results of conventional vulcanization. It was established that the tensile strength and modulus of the radiation-treated films were lower than those of a sulfur-vulcanized film, but the elongation and tear strength were higher. (J.S.R.)

Materials Modification

9360 PROPERTIES OF IRRADIATED-CROSSLINKED POLYETHYLENE CABLE. Tsuji, Y.; Tada, S.; Furuhashi, K. *Sumitomo Denki*, No. 92, 65-71 (May 1966). (In Japanese).

Properties of irradiated-crosslinked polyethylene and electrical wire insulated with irradiation-crosslinked polyethylene are discussed. The conclusion is that irradiation-crosslinked polyethylene wire has properties equal to those of unirradiated polyethylene at room temperature and a lifetime of two to three years at 100°C. (auth)

13292 USE OF IRRADIATED POLYETHYLENE FOR TELEPHONE CABLE AND RADIO FREQUENCY COAXIAL CABLE. Miyamori, S.; Ishikawa, K.; Uda, Y. *Sumitomo Denki*, 94: 80-8 (Dec. 1966). (In Japanese).

There are some cases in which heat resistance becomes necessary for polyethylene insulated telephone and rf coaxial cables. In

case of wiping or soldering cable conductors for instance, the cable insulation should not be allowed to melt or deform, because it has to retain excellent electrical properties. In this case, it is very useful to use irradiated polyethylene, which does not melt or deform at high temperatures, to the cable insulation instead of conventional polyethylene. The use of irradiated polyethylene for the insulation of telephone and rf coaxial cables is discussed. (auth)

5966 METHOD FOR IRRADIATING LONG-FILAMENT MATERIALS WITH IONIZING RADIATION. Shinohara, Yasuo (to Toyo Rayon Co., Ltd.). Japanese Patent 1965-28157. Dec. 13, 1965. Filed June 15, 1963.

A simple and efficient method is proposed for uniformly irradiating long-filament materials (such as thread, cord, or wire) with ionizing radiation. The material is wound around a drum at constant thickness, and the drum is passed through the radiation field while it is rotated. It is desirable for the drum to be a cylindrical one, but a multi-angled one may also be used. The thickness of threads etc., wound around the drum should be such that the radiation just penetrates through it. The material to be irradiated can either be wound prior to the irradiation process or while the drum is rotated in the radiation field. (NSA of Japan)

10400 EFFECT OF γ RADIATION ON POLYESTERS OF ADIPIC ACID AND DIETHYLENE GLYCOL. Apukhtina, N. P.; Zaitsev, N. B.; Rappoport, L. Ya.; Kozlova, N. V. *Plast. Massy*, No. 8, 60-2 (1966). (In Russian).

In a study of the effect of γ radiation on saturated aliphatic polyesters (which are used as the main component in urethane polymers), polydiethylene adipates (PDEA) of molecular weight (MW) ~2000 and 4000 of the structure

were irradiated with radiation from ^{60}Co . The amount of absorbed energy was determined by ferrous sulfate dosimetry. A study of the dependence of the relative viscosity of benzene solutions of the polyesters on the dose absorbed showed a predominant role of cross-linking of PDEA during the irradiation, this effect being more pronounced as MW increases. Infrared spectroscopic data indicated that the polyester chains break down at the ester group, forming CO and CO_2 ; this was associated with a decrease in the quantity of C=O bonds and the appearance of unsaturation in the chain as the dose increased. The cross-linking occurred at the methylene groups. The different positions of the ir bands of α and β methylene groups made it possible to evaluate the relative rates of disappearance of these two types of groups under the influence of γ radiation. The polyester with MW ~4000 irradiated with 200 Mrad converted into a rubberlike elastomer consisting of a mixture of cross-linking and degradation products. Hard, cross-linked polyurethanes were successfully obtained from the irradiated polyesters at equimolar ratios of polyester to 2,4-toluylene diisocyanate at moderate temperatures (60 to 70°C). The degree of cross-linking of polyurethanes as a function of the dose was determined from the glass transition temperature of the polymers. (ATD)

Chemicals Manufacture

1386 EFFECT OF REACTION CONDITIONS ON THE FORMATION OF POLYSULFONE OF OLEFINS WITH SULFUR DIOXIDE INDUCED BY γ RADIATION, AND THE SEVERAL PROPERTIES OF THE POLYSULFONES. Urano, Yokichi; Hosaka, Yoshinobu. *Tokyo Kogyo Shikensho Hokoku*, 61: 352-7 (Aug. 1966). (In Japanese).

Polysulfone reaction of lower olefins (ethylene, propylene, butene-1 and butene-2) with sulfur dioxide initiated by γ -radiation was carried out using a stainless steel reactor with the following experimental conditions: temperature, -78 to 100°C; mole fraction of olefin, 0.2 to 0.9; reaction duration, 0.25 to 24 hr; and dose rate of 3×10^4 to 4×10^4 RAD/hr. The polysulfones thus obtained were white powder, which could be molded with a hot press. The maximum yields were obtained at around 0°C and 0.5 mole fraction of olefins for all combinations. Some physical properties and stabilities toward heated and alkaline solutions of the polysulfones are tabulated. (auth)

1384 RADIATION-INDUCED ADDITION REACTION OF THIOLS TO CHLOROFLUOROOLEFINS. Inukai, Kan; Ueda, Teruo; Muramatsu, Hiroshige (Government Industrial Research Inst., Nagoya, Japan). *Bull. Chem. Soc. Japan*, 39: 2191-4 (Oct. 1966).

The addition of thiols to chlorofluoroethylenes was carried out under γ -ray irradiation; chlorofluoroethyl alkyl sulfides were thus obtained. Chlorofluoroethyl alkyl sulfoxides and sulfones were prepared by the oxidation of the sulfides. The dehydrohalogenation of chlorofluoroethyl alkyl sulfides yielded chlorofluorovinyl alkyl sulfides, whose structure indicated that the thiyl radical attacked the difluoromethylene side of the asymmetrical dichlorodifluoroethylene. Chlorofluorovinyl sulfoxides and sulfones were also synthesized from the sulfides by oxidation with hydrogen peroxide. (auth)

19658 ELECTRON AND γ -RAY INDUCED ADDITION OF ACETONITRILE TO OLEFINS. Rokach, J.; Krauch, C. H. (Max-Planck-Institut fuer Kohlenforschung, Muelheim, Ger.). *Naturwissenschaften*, 54: 166-7 (1967).

The electron and gamma-induced reaction of acetonitrile with olefins was studied. Because of radical stabilities and the influence of steric factors, only anti-Markownikoff products were obtained. After irradiation with electrons, succinonitrile was isolated indicating the participation of the CH_2CN radical in the radiation chemical reaction. Linear energy transfer effects presumably are of importance in the electron irradiation experiments as succinonitrile was formed with high dose rates. There was no formation of succinonitrile when gamma irradiation was applied. The olefins used, the products, the chemical yield, and G-values are given. (D.H.M.)

15926 SYNTHESIS OF AMINO ACIDS BY ^{60}Co GAMMA IRRADIATION. Rai, Tokan; Shinagawa, Mutsuaki (Osaka Univ.). *J. Nucl. Sci. Technol. (Tokyo)*, 4: 42-3 (Jan. 1967).

Solutions containing a mixture of 0.05M of fumaric acid and 1M of ammonium hydroxide were irradiated with γ rays from a 500 Ci ^{60}Co source. A dose rate of 3×10^4 R/hr was applied, and the total dose amounted to 3×10^6 R per sample. The irradiated solutions were analyzed for content of amino acid and the amino acid was confirmed to be aspartic acid. The amount of aspartic acid formed was calculated to be 6×10^{-5} moles from 5×10^{-4} moles of fumaric acid. (M.C.G.)

1373 (AERE-R-5236) RADIATION-INITIATED CARBOXYLATION OF CYCLOHEXANE. Hills, P. R. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Sept. 1966. 12p. (CONF-660614-7). BIS \$0.50. HMSO 2s. 6d. From 3rd International Congress on Radiation Research, Cortina, Italy.

In irradiated cyclohexane solutions, oxalyl chloride reacts by a chain mechanism to afford the acid chloride of cyclohexane carboxylic acid. No such reaction was observed in cyclohexene solutions. G-values varying from 200 to 750 are reported, which are dependent on the concentration of oxalyl chloride but apparently independent of the dose rates employed. The data obtained can be expressed in the relationship: $G\text{-value} = k[c]^a$, where c is the mole fraction of oxalyl chloride and the exponent, a , equals 0.69 ± 0.02 . (auth)

NH_3 Synthesis

10397 INVESTIGATIONS ON RADIATION-CHEMICAL AMMONIA SYNTHESIS IN NUCLEAR REACTORS. Schrader, Richard; Schoenherr, Siegfried (Institut fuer Anorganische und Analytische Chemie der Bergakademie, Freiberg i. B.). *Z. Anorg. Allg. Chem.*, 348: 168-74 (Dec. 1966). (In German).

The formation of ammonia under the influence of mixed-reactor radiation and γ radiation was investigated using different nitrogen-hydrogen mixtures at approximately normal pressure and temperature without catalysts. The highest ammonia yield of 2.6% was obtained for 5.15×10^5 RAD of mixed radiation, equivalent to $G(\text{NH}_3) = 0.16 \pm 0.03$. It was concluded from the dependence of ammonia yield upon the gas composition and kind of radiation that the course of reaction is different for mixed-reactor and γ radiation. (auth)

HCN Synthesis

105 RADIOLYTIC SYNTHESIS OF PRUSSIC ACID BY IRRADIATION OF AMMONIUM AND HYDROCARBON MIXTURES BY ACCELERATED ELECTRONS. Dzantiev, B. G.; Trubnikov, V. P.; Popov, V. N. (Inst. of Chemical Physics, Academy of Sciences, USSR. Inst. of Nuclear Energy, Academy of Sciences, Belorussian SSR). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk*, No. 3, 5-7 (1966). (In Russian).

Mixtures of $\text{NH}_3\text{-CH}_4$ and $\text{NH}_3\text{-C}_2\text{H}_4$ in a stainless steel vessel were irradiated with 600-keV electrons from an accelerator. The dose was determined by ionization chamber readings, or chemically by the amount of nitrogen oxides formed on irradiating air samples with the 600-keV electrons. After irradiation the irradiation vessel was flushed with a slow stream of air, and the hydrogen cyanide (HCN) was condensed out in a liquid nitrogen trap. The HCN content was determined photocolometrically from the reaction of bromine cyanide with a pyridine-benzidine complex in acid solution. The lower limit of detection was $0.1 \mu\text{g}$ HCN/ml. The G yield of HCN was 0.05 mols/100 eV of absorbed energy, which remained constant up to 10^{18} eV/ml. The maximum concentration of HCN in the mixture did not exceed 0.1%. The optimum composition was 80% $\text{NH}_3\text{-20\% CH}_4$ in one system with a G yield of 0.07, and 60% $\text{NH}_3\text{-40\% C}_2\text{H}_4$ in the other system with a G yield of ~ 0.045 molecules/100 eV. (TTT)

107 PRODUCTION OF PRUSSIC ACID BY IRRADIATION OF AMMONIUM AND HYDROCARBON MIXTURES IN ATOMIC REACTOR. Dzantiev, B. G.; Trubnikov, V. P.; Popov, V. N. (Inst. of Chemical Physics, Academy of Sciences, USSR. Inst. of Nuclear Energy, Academy of Sciences, Belorussian SSR). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk*, No. 3, 8-12 (1966). (In Russian).

Mixtures of ammonia with methane, ethylene, and acetylene were irradiated in a reactor under static conditions at pressures of 3 to 10 atm in polyethylene containers. The absorbed dose was determined using an ionization chamber, or chemically by using a gaseous N_2O dosimeter. The thermal neutron flux was found, by activation of known amounts of NaF from the reaction $^{23}\text{Na}(n,\gamma)^{24}\text{Na}$, to be 0.35 to 2.7×10^{12} neutrons $\text{sec}^{-1} \text{cm}^{-2}$. In the ammonia-ethylene mixture, a maximum G yield of 0.02 molecules of HCN/100 eV was attained at a composition of 65% of $\text{NH}_3\text{-35\% C}_2\text{H}_4$. The maximum G yield was ~ 0.031 molecules of HCN/100 eV at an optimum composition of 70% $\text{NH}_3\text{-30\% acetylene}$. The maximum G yield was only 0.01 molecules/100 eV for a 60% $\text{NH}_3\text{-40\% CH}_4$ mixture, but this yield rose to 0.045 molecules of HCN/100 eV on adding a small amount of activated charcoal to the system. The yield then tended to decrease slightly with increasing initial gas pressure of the reactants. The presence of small amounts of nitrogen oxides decreased the HCN yield practically to zero. It is believed that HCN is formed according to the following reactions: $\text{N} + \text{C}_2\text{H}_4 \rightarrow (\text{C}_2\text{H}_4\text{N}) \rightarrow \text{HCN} + \text{CH}_3$; $\text{C}_2\text{H}_5\text{NH}_2^+ \rightarrow \text{HCN} + \text{CH}_4 + \text{H}_2$; and $\text{N} + \text{C}_2\text{H}_4 \rightarrow (\text{C}_2\text{H}_2\text{N}) \rightarrow \text{HCN} + \text{CH}$. Ethylene also tended to form a polymer on being irradiated in the presence of ammonia. (TTT)

106 RADIOSYNTHESIS OF PRUSSIC ACID BY IRRADIATION OF NITROGEN AND HYDROCARBON MIXTURES BY ACCELERATED ELECTRONS. Dzantiev, B. G.; Trubnikov, V. P. (Inst. of Chemical Physics, Academy of Sciences, USSR. Inst. of Nuclear Energy, Academy of Sciences, Belorussian SSR). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk*, No. 3, 13-15 (1966). (In Russian).

Mixtures of nitrogen with methane, ethylene, or acetylene were irradiated with 600-keV electrons from an accelerator. The maximum G yield of HCN was 0.03 for 50% $\text{N}_2\text{-50\% ethylene}$, 0.05 for 50% $\text{N}_2\text{-50\% acetylene}$, and 0.075 molecules/100 eV at an optimum composition of 80-90% N_2 and 10-20% CH_4 . The addition of argon or helium to the nitrogen-methane mixture increased the G yield of HCN by a factor of two. The G yield of HCN increased with increasing gas pressure of the reactants. In principle these reactions can also be carried out in a reactor. (TTT)

Oxidation

1402 METHOD FOR PRODUCING ALICYCLIC LACTONES. Tsuda, Teizo (to Toyo Rayon Co., Ltd.). Japanese Patent 1965-22177. Oct. 1, 1965. Filed July 2, 1963.

A method is proposed for producing alicyclic lactones by oxidation of alicyclic ketones. The ketones are oxidized to lactones by irradiating them with ionizing radiation at 0 to 160°C in the presence of aromatic aldehydes while molecular oxygen is blown into them. (NSA of Japan)

5969 METHOD FOR PRODUCING HELIOTROPINE PERFUME BY RADIATION. Kinoshita, Shosaku. Japanese Patent 1965-22463. Oct. 5, 1965. Filed Nov. 27, 1962.

A method is proposed for the production of heliotropin perfume by irradiation of isafrol, an aromatic compound, in the presence of oxygen. The process is simple and can give a high yield of the good-quality perfume. In the cosmetics industry, heliotropin is important as the basic ingredient for the heliotrope perfumes and also as a modifier of general use. (NSA of Japan)

12466 RADIATION-INDUCED OXIDATION OF METHANOL. Ladygin, B. Ya.; Saraeva, V. V. Kinet. Kataliz, 7: 967-76 (Nov.-Dec. 1966). (In Russian).

Studies of the gamma-induced oxidation of liquid methanol showed that at low temperatures the yields did not depend on the temperature or the dose. At temperatures above 0°C the yield increased sharply with an increase in temperature. Reduced dosage resulted in increased yields of H_2O_2 and CH_2O . The yield of radicals initiating the oxidation process at various temperatures was calculated. The energy of activation of the chain initiating reaction, the ratio of the growth constant to chain breakage, and the balance of oxidation products at low temperatures were determined. (tr-auth)

1399 RADIATION-INDUCED OXIDATION OF ETHANE IN AQUEOUS SOLUTION. Ahmad, M.; Clay, P. G. (Imperial Coll. of Science and Tech., London). J. Chem. Soc., B, No. 9, 845-9 (1966).

Aqueous solutions of ethane-oxygen mixtures were irradiated with γ rays, at room temperature; the major products were acetaldehyde, ethanol, and ethyl hydroperoxide, the last being formed at pH 5.5 and 10 but not at pH 1.2. Photolysis of hydrogen peroxide solutions containing dissolved ethane and oxygen resulted in the formation of ethanol and acetaldehyde only. The results were interpreted in terms of reactions of ethyl peroxy radicals. (auth)

12477 RADIATION-CHEMICAL OXIDATION OF BUTANOL. EFFECT OF BUTANOL CONCENTRATION ON THE COMPOSITION AND YIELD OF PRODUCTS. Komarov, P. N. Petrol. Chem. (USSR) (Engl. Transl.), 5: No. 4, 303-9 (1966).

A comparative study was made of the ^{60}Co radioinduced oxidation of pure butanol and butanol in aqueous solution (concentration 0.98 mole/l) at a temperature of 150°C. Variation of the ratio between the reaction products, observed on changing from oxidation of the absolute alcohol to its radioinduced conversion in an aqueous solution (0.98 mole/l), was due to the reduction of alcohol concentration. In the radioinduced oxidation of absolute butanol, ^{60}Co γ radiation, in addition to stimulating the initial stage of the process, stimulated the oxidation of n-butyraldehyde, formed during the reaction, to n-butyric acid. A reaction mechanism showing a step-by-step sequence is proposed. This scheme is based on the amounts of ethylene glycol, acetaldehyde, and acetic acid in the reaction products. The conversion, according to reactions proposed, accounts for the formation of identical amounts of ethylene glycol and acetaldehyde, on the one hand, and of acetic acid, on the other. The observed increase in the proportion of ethylene glycol, acetaldehyde, and acetic acid in the reaction products in oxidation in aqueous solution is considered proof of the preferential formation of the radical $CH_3CHCH_2CH_2OH$ in the aqueous phase. All the products observed are also seen in appreciable quantities in pure alcohol during thermal oxidation. This points to the fact that in liquid-phase oxidation of butanol the reaction chain is formed by 2 independent pathways, which are not related to the means of formation of initial active centers. An increased content of these products on oxidation in solution can be explained by the reduction in alcohol concentration. (BBB)

14245 RADIATION-INDUCED OXIDATION OF SOME ORGANIC SUBSTANCES WITH MOLECULAR OXYGEN. Saraeva, V. V. (Lomonosov State Univ., Moscow). Petrol. Chem. (USSR) (Engl. Transl.), 5: No. 4, 257-67 (1966).

The characteristic features of radioinduced oxidation of various organic compounds with molecular oxygen were considered. Radiation, radiation-thermal, and thermal-radiation type reactions were examined. The conditions in changing from one process to another were established. The effect of dose rate in going from a radiation to a radiation-thermal process was considered. Using the limited data available in the various ranges of temperatures, a curve was plotted by the proposed methods to show the dependence of yields on temperature for various dose rates. The radioinduced oxidation reactions studied concerned the oxidation of isooctane, heptane, isopropyl ether, and isopropyl alcohol. In the low-temperature region the yield of oxidation products depended very little on temperature and was practically independent of dose rate. In view of the fact that the mechanisms of formation of oxidation products were not established with sufficient reliability, the discussion is based entirely on hydrogen peroxide formation. As to the transition from the radiation range to the radiation-thermal range it was pointed out that the temperature at which chain processes take place decreases as the dose rate is decreased. (BBB)

Chlorination

5967 METHOD FOR PRODUCING CHLORINATED POLYMERIC SUBSTANCES BY IONIZING RADIATION. Okamura, Seizo; Hayashi, Koichiro (to Japanese Association for Radiation Research on Polymers). Japanese Patent 1965-25907. Nov. 11, 1965. Filed Oct. 1, 1958.

A new method for producing chlorinated polymeric substances at high yields in a wide range of chlorine contents includes irradiating the polymeric substances with ionizing radiation in the presence of chlorine, with or without use of organic liquids proper to the polymeric substances. (NSA of Japan)

3097 SOLID STATE CHLORINATION OF POLYPROPYLENE BY IONIZING IRRADIATION. Dzhagatspanyan, R. V.; Korolev, B. M.; Zetkin, V. I.; Filippov, M. T. Vysokomol. Soedin., 8: 1745-53 (Oct. 1966). (In Russian).

In the solid state chlorination of polypropylene caused by γ irradiation there is a chain reaction in the volume of polymer ($G \approx 10^5$ chlorine atoms/100 eV). At the first stage of the reaction only the amorphous phase of polymer is chlorinated. The reaction rate is proportional to chlorine pressure and polymer concentration. Chain termination is close to linear. An intradiffusional reaction mechanism is proposed. (auth)

19653 RADIATIVE CHLORINATION OF PHENYLMETHYLDICHLOROSILANE AND PHENYLTRICHLOROSILANE. Filippov, M. T.; Dzhagatspanyan, R. V.; Motsarev, G. V.; Rozenberg, V. R.; Zetkin, V. I. Zh. Obshch. Khim., 37: 267-71 (Jan. 1967). (In Russian).

The singularities of ^{60}Co γ -induced chlorination of phenyltrichlorosilane and phenylmethyldichlorosilane at 0 to 150°C were analyzed. Radio-chlorination of phenylmethyldichlorosilane and phenyltrichlorosilane at 0°C was similar to the photochemical and to the chlorination-forming products of chlorine attachment to the aromatic nucleus; while at 100°C and over replacements in aromatic nucleus formed the product. Certain features of radiation displacement at 100 to 150°C were not in agreement with the concepts of the radical-reaction mechanisms. The linear dependence of the rate of phenylmethyldichlorosilane chlorination on the dose and the absence of inhibiting oxygen effects represent such peculiarities. (R.V.J.)

12487 METHOD FOR THE PRODUCTION OF CHLORINE-CONTAINING CYCLIC ETHERS. Matsuda, Tatsuo (to Agency of Industrial Science and Technology, Tokyo). Japanese Patent 1966-4708. Mar. 15, 1966. Filed May 20, 1963.

A method is proposed for the production of chlorine-containing cyclic ethers, namely, saturated chlorine-containing cyclic ethers, which are the 1:1 addition compounds of tetrachloroethylene and cyclic ethers, and the unsaturated chlorine-containing cyclic ethers,

which have the dehydrochlorinated structure of the corresponding saturated ones, by the utilization of an ionizing radiation including x rays or of a catalyst initiating the free-radical reactions. For example, when tetrahydrofuran is used as the cyclic ether, the products are 2-(1,1,2,2-tetrachloroethyl)tetrahydrofuran and 2-(1,2,2-trichlorovinyl)tetrahydrofuran, and when the cyclic ether is paradioxane, 2-(1,1,2,2-tetrachloroethyl)paradioxane and 2-(1,2,2-trichlorovinyl)paradioxane are obtained. It is possible to select the free-radical generating sources and the reaction conditions in order to obtain either the saturated or the unsaturated chlorine-containing cyclic ethers as the main product. (NSA of Japan)

19713 PROCESS OF PREPARING CHLORINATED HYDROCARBONS. (to Japan Atomic Energy Research Inst.). British Patent 1,055,410. Jan. 18, 1967. Priority date Sept. 22, 1964, Japan.

A process is described for the radioinduced reaction of Cl_2 gas with a saturated or partly chlorinated saturated hydrocarbon having not more than 7 C atoms. The process is also applicable to the chlorination of solid or molten paraffin. The ionizing radiation may be either gamma radiation from a ^{60}Co source or an electron beam. (B.L.M.)

Catalysis

10391 THE EFFECTS OF NEUTRON IRRADIATION ON METHANOL OXIDATION CATALYSTS. Gevaert, L. H.; Jervis, R. E. (Univ. of Toronto). *J. Catalysis*, 6: 200-8 (Oct. 1966).

Oxidation of methanol to formaldehyde was studied over a temperature range from 209 to 270°C in a differential flow gas-phase reactor using catalysts irradiated with neutron doses up to 10^{20} neutrons/cm². Attempts were made to correlate the altered catalytic activity to defects produced by radiation damage and to a quantity of foreign atoms introduced throughout the catalyst by nuclear transmutations. The catalysts investigated were pure V_2O_5 , V_2O_5 mixed with 1% chromium oxide, and a mixed tungsten oxide-molybdenum oxide. The gaseous reactant stream consisted of 20% oxygen, 0.75 to 6% methanol, and the remainder, nitrogen. The doped V_2O_5 (1% chromium) catalyst was found to be 30 to 50%

more active than pure V_2O_5 with or without irradiation. The tungsten-molybdenum mixed oxide catalyst was 25% more active for methanol oxidation after irradiation and was 6 to 10% more active even after high-temperature annealing. By calculation from nuclear constants it was determined that 0 to 0.03% chromium and 0 to 0.06% rhenium were introduced by nuclear transmutation in the V_2O_5 and tungsten-molybdenum oxide catalysts, respectively. No significant differences in reaction mechanism or energy of activation were observed between the unirradiated and irradiated catalysts. (BBB)

1396 CHANGE IN CATALYTIC ACTIVITY OF ALUMINA IN DEHYDRATION REACTIONS OF n-DECYL ALCOHOL AND IN ISOMERIZATION OF α DECENE BY MEANS OF IRRADIATION. Pirogova, G. N.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Academy of Sciences, USSR). *Izv. Akad. Nauk SSSR, Ser. Khim.*, No. 10, 1691-4 (1966). (In Russian).

The effects of fast electrons, uv rays, mixed neutrons, and radioactive ^{90}Y on the catalytic dehydration of 1-decanol over Al_2O_3 and isomerization of produced α -decene were investigated. Irradiation of alcohol vapors by fast electrons does not affect its catalytic conversion. Preliminary treatment of aluminum oxide by uv rays also does not influence Al_2O_3 catalytic activity. Uv irradiation during alcohol vapor reactions with the catalyst inhibited olefin yield, but treatment of Al_2O_3 with mixed slow and fast neutrons ($10^{13}\text{n/cm}^2\cdot\text{sec}$) in a reactor does not increase catalytic activity. Injection of ^{90}Y (5 m Cu/g) reduced the degree of alcohol conversion. A partial reduction of the initial activity is achieved during radioactive decay. (tr-auth)

4565 APPLICATION OF RADIOACTIVE CATALYSTS TO DEHYDRATION OF SPIRITS. Spitsyn, Vikt. I.; Mihailenko, I. E. *At. Energ. (USSR)*, 21: 277-81 (Oct. 1966). (In Russian).

Radiation effects on catalytic processes were analyzed. It is shown that radioactive admixtures to the catalyst considerably altered the rate and energy of the apparent alcohol dehydration and in some cases the direction of the heterogeneous-catalytic reactions. Radiation changed the quality of the catalyst and strongly influenced the adsorbed layer of molecules on the catalyst surface by inducing their polarization. The polarization magnitude depended on the structure of reacting molecules. (tr-auth)

SOURCE AND IRRADIATOR DEVELOPMENT

4589 MEASUREMENT OF THE ACTIVITY OF HIGH-ACTIVITY ^{60}Co SOLID SOURCES BY THE APPLICATION OF NUCLEAR PHOTO EFFECT. Veres, A.; Pavlicsek, I.; Ozsganyi, M. (National Atomic Energy Commission, Budapest). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/5, 8p. (CONF-661012-27). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Experimental results obtained by measuring the activity of ^{60}Co sources with activities between 20 and 3000 Ci by the application of nuclear photo effect are presented. To determine the activity of the irradiating source the isomeric activities of $^{115\text{m}}\text{In}$ and $^{111\text{m}}\text{Cd}$ were used. The method provides an accuracy of about 5%. Due to the simplicity and good feasibility of the measurement the method offers many advantages within the activity range from 10 to 10^4 Ci. Besides ^{60}Co sources two others can be measured in the range mentioned above, provided they have gamma radiation of an energy higher than 1 MeV. By means of this method and by selecting an adequate target for detector, equipment for very rapid measurements can be constructed. (auth)

7642 ABSOLUTE CALIBRATION OF NEUTRON SOURCES BY MnSO_4 ACTIVATION. Andrási, Andor; Deme, Sandor; Nagy, Judit. Magyar Tud. Akad. Kozp. Fiz. Kut. Int. Kozlem., 14: 267-80 (1966). (In Hungarian).

The absolute neutron emission rate was determined for fast neutron sources from the activation of MnSO_4 solutions. The ^{56}Mn activity produced in the solution was measured using a scintillation counter assembly calibrated with a high specific activity ^{56}Mn solution standardized previously by $4\pi\beta$ counting. With the use of this method, the neutron emission rate of a Ra-Be source was measured to be 3.35×10^6 sec. The standard error of the measurement was $\pm 1.5\%$. The measured value is 3% less than the rated yield of the source. The measuring technique, the calculating process, and the factors affecting the accuracy of the method are discussed. (auth)

21393 A CRITICAL COMPARISON OF THREE METHODS OF ABSOLUTE YIELD MEASUREMENTS FOR NEUTRON SOURCES. Yaritsina, I. A. (Mendeleev Inst. of Metrology, Leningrad). pp 318-21 of Proceedings of the International Conference on Radiation Measurements in Nuclear Power,

Berkeley Nuclear Laboratories (C.E.G.B.), Gloucestershire, England, Sept. 1966. London, The Institute of Physics and The Physical Society, [1967].

Three independent methods for absolute measurement of the number of neutrons emitted by a source are described. Each of these methods can be used with success in one circumstance or another. By considering in detail each of the methods studied, their relative advantages are determined in order to select the most appropriate method for a particular problem. The methods of associated particles, manganese activation and gold foil activation comprise the three methods described. Each of these methods and the proper measuring equipment are described elsewhere and attention in this paper is mainly drawn to sources of error in each of the methods. (auth)

2598 METHOD OF CALIBRATING NEUTRON SOURCES. Capgras, A. (CEN de Saclay, Gif-sur-Yvette, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/64, 14p. (In French). (CONF-660807-14). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

The apparatus described is used calibrating neutron sources. An integration method based on manganese activation is used. The activation is not measured on samples (discontinuous method) but by a continuous method: a pump circulates the moderating solution around the detector from a 1-meter diameter sphere which contains the solution and in the center of which the neutron source is placed. The apparatus has various special features: maintenance of constant detector temperature; reheating of the solution by a thermostat placed at the input of the detector cell, which ensure

good spectral stability for the period of 30 hours covered by the measurement. The activity of the source is calculated from a differential equation which gives the instantaneous activity of the manganese; this equation involves the use, among other parameters, of the circulation rate of the bath. Correction factors are calculated or measured, some of them being common to the different types of source and others being specific. The apparatus is used to measure the activity of α -n sources of different types (Ra-Be, Pu-Be, Po-Be, Am-Be, Po-Li) with an accuracy varying between 2 and 1.1% for a neutron emission between 10^5 and 10^7 ns⁻¹. The accuracy obtained with the usual method of sampling would be between 7 and 2% owing to the large statistical error. The continuous method thus considerably improves the standard of the measurements. (auth)

Irradiation Facilities

17758 THE "NAYADE" ⁶⁰Co IRRADIATION UNIT. Fornas Izquierdo, E.; Del Val Cob, M.; De La Cruz Castillo, F. *Energ. Nucl. (Madrid)*, 10: 376-88 (Sept.-Oct. 1966). (In Spanish).

The characteristics and construction of the "Nayade" radiation facility are described. The dosimetry methods used are outlined. (J.S.R.)

237 USE OF AMPOULE WITH HYDRAULIC BLOCK IN LARGE GAMMA-RADIATION INSTALLATIONS FOR CHEMICAL PURPOSES. Bykhovskii, A. V.; Drozdov, V. E.; Lisov, G. N. *At. Energ. (USSR)*, 21: 63-4 (July 1966). (In Russian).

Ampoules developed for gamma sources stored under water in irradiation facilities are described. Two types of ampoules have been developed for use in installations with and without manipulators. If the source is always under water, a system of two cylindrical containers is used; if the source is removed from the water during irradiation experiments, a third container is provided to maintain the integrity of the hydraulic lock. With manipulators, all charging operations may be carried out under the protective water layer. Removal of heat is provided. (TTT)

10136 DOSE-RATE FIELD OF AN IRRADIATOR WITH USED FUEL ELEMENTS AS THE SOURCE OF GAMMA RADIATION. Drozdov, V. E.; Zakharova, I. M.; Dobrovolskii, S. P. *J. Nucl. Energy: Pt. A and B*, 20: 1011-18 (Nov.-Dec. 1966).

Experiments were carried out on the RFT reactor to determine the activity distribution along a fuel element. It was shown that the distribution of activity is satisfactorily described by a cosine function, and that the equations used to calculate the dose-rate field for irradiators with an even distribution of activity along the radiation source are inapplicable when such sources are fuel elements [the discrepancy is 23% for RFT and 32% for the First Atomic Power Station (AES)]. Good agreement was obtained between calculations and the experimental data. (tr-auth)

16075 SELECTION OF A RADIATION SOURCE FOR IRRADIATING BULK MATERIALS. Bibergal', A. V.; Primak-Mirolyubov, V. N. *At. Energ. (USSR)*, 22: 55-8 (Jan. 1967). (In Russian).

The effectiveness of irradiation of grains and potatoes to kill insect pests and to prevent germination has been well established. The process is best carried out by moving the materials continuously in front of a radiation source. Geometrical considerations play an important role in ensuring a constant absorbed dose throughout the bulk of the material. The cylindrical configuration was more closely examined, determining the efficiency of the system on the basis of the total activity of the central source and the distance of the moving material. The calculations indicated that about 30% of the radiation energy may be absorbed usefully. The efficiency of an irradiating system consisting of a single linear source was found to be lower than that of a more complex system. Only qualitative conclusions could be drawn because "dead angles," reaching areas free from material to be irradiated, were not taken into account. (TTT)

1856 IRRADIATION FACILITIES. *Food Irradiat.*, 6: No. 4, A1-54 (Apr.-June 1966).

Irradiation facilities operative in 1966 in Belgium, Canada, Denmark, France, Germany, Japan, The Netherlands, Spain, United Kingdom, and the United States are described briefly. Drawings and photographs of many of the facilities are given. Data on the source, purpose, radiation doses produced for various applications, and dosimetry methods used are included. The facilities are primarily for food irradiation but some are also used for the irradiation of industrial materials. Radiation sources used include ⁶⁰Co γ sources, irradiated reactor fuel elements, and electron linear accelerators. Applications of radiation in food processing in the USSR and Thailand are discussed briefly. (C.H.)

19855 THE FIRST INDUSTRIAL GAMMA IRRADIATION PLANT ON THE EUROPEAN CONTINENT. Kuenzli, A.; Baur, P. *Suizer Tech. Rev.*, 48: 84-7 (1966).

The first industrial gamma irradiation plant on the European continent is described. Disposable surgical equipment is effectively and economically sterilized by gamma radiation from a ⁶⁰Co source. Except for filling and emptying the irradiation containers, the process is automatic. Less stringent sterility is required in the work rooms because the radiation dose administered guarantees sterility in the end product even when operating under nonsterile conditions. (L.C.L.)

215 GAMMA RADIATION FACILITY OF STATIONARY TYPE. Ney, Włodzimierz (Inst. of Nuclear Research, Warsaw). *Nukleonika*, 11: 415-20 (1966). (In Polish).

A stationary γ facility of 1000 C ⁶⁰Co for physico-chemical investigations is described. The facility utilizes new construction ideas such as nonelastic source pipes, the construction of which gives the possibility of changing the shape and size of the source, mechanical changing of the radioactive units, and movable biological shields enabling repairing and dismantling of the facility. (auth)

6166 (IA-1082, pp 311-18) MECHANICAL ENGINEERING. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

Work was carried out during 1965 on the design and installation of the industrial gamma irradiation facility and the liquid waste disposal system. (R.C.K.)

16552 GRAIN IRRADIATION PLANT. *Engineer*, 223: 97-8 (Jan. 20, 1967).

The first full-scale application of radiation from a ⁶⁰Co source for insect disinfection of grain has been installed in Turkey. Specifications of this irradiation plant that is designed to treat wheat, barley, rye, and maize at rates up to 50 ton/hr, with a dose sufficient to sterilize the insects in the grain are outlined. With the initial loading of 163,000 C of ⁶⁰Co the plant can continuously treat grain at a rate of 30 ton/hr. The grain irradiation facilities and the process used are described. Safety features and economic aspects of grain irradiation are also discussed. (TSS)

16553 PRESENTATION OF THE PILOT PLANT FOR FOOD IRRADIATION. Lindhout, A. H. *Atoomenergie Haar Toepass.*, 8: 243-4 (Nov. 1966). (In Dutch).

A pilot plant for food irradiation to test commercial applications was inaugurated. The purposes of the installation were briefly discussed. The installation has two radiation sources, a γ source and an electron generator. A sketch is given of the γ source. (J.S.R.)

10516 AUTOMATIC IRRADIATION FACILITY FOR STERILIZATION OF SURGICAL SUTURES. Muxfeld, H. (Ethicon GmbH, Glashuette, Ger.). *Kerntechnik*, 8: 470-2 (Oct. 1966). (In German).

The construction, function and safety interlock system of a new automatically working cobalt-60 plant for sterilization of surgical sutures are described. The plant is built to house 750,000 Ci. Problems of the bactericidal effect of ionizing radiation are discussed. (auth)

1549 IRRADIATION FACILITY WITH RADIOACTIVE RADIATION SOURCES. Baur, Peter (to Gebrüder Sulzer Aktiengesellschaft). German Patent 1,221,369. July 21, 1966. Priority date Mar. 11, 1965, Switzerland.

The irradiation facility is comprised of a vertically movable plate within a shielded irradiation chamber provided with parallel, horizontal channels in which the radioactive sources are located, and a means for exchanging simultaneously the radiation sources in two neighboring channels. The radiation sources are exchanged by means of a horizontal port in the concrete shielding wall, a stepped steel sleeve lining the wall of the port, and within the sleeve, a fixed lead plug adjacent to irradiation chamber, which is provided with two channels to be brought into alignment with two of the parallel channels in the source plate when the plate is vertically moved, and a rotatable plug facing the outside of the shielding wall which is supported on ball bearings and is penetrated by one eccentric channel which is brought into alignment with the channels in the fixed plug when the outer plug is rotated. (Gmelin Inst.)

12556 GAMMA-RAY IRRADIATION FACILITY FOR BIO-CHEMICAL RESEARCH. Hatano, Hiroyuki (Kyoto Univ.); Ganno, Shigetake; Sumizu, Koichi; Ohnishi, Shunichi; Kimura, Nobuaki; Imai, Takeshi; Tsuzuki, Tadaichi. J. Radiat. Res. (Jap.), 7: 67-82 (June 1966).

A gamma-ray irradiation facility with a 100 Ci cobalt-60 source was designed as a unit type for use in radiation biochemistry, and installed in the Department of Chemistry, Kyoto University in 1963. This facility is able to achieve irradiation at moderate dose rates of the range from 6×10^3 to 5×10^4 roentgens per hour and is easily manipulated manually. The facility was equipped with a temperature control system and a circulating system for flowing liquid materials during exposing to gamma ray irradiation. (auth)

Power Sources

16080 IMPROVEMENTS IN OR RELATING TO NUCLEAR-POWERED ELECTROMAGNETIC SIGNAL GENERATORS. (to Saint-Gobain Techniques Nouvelles). British Patent 1,058,678. Feb. 15, 1967. Priority date June 7, 1963, France.

A ^{90}Sr isotopic signal generator which is used in producing electromagnetic radiation in the form of successive impulses is described. A capacitor is provided to store energy produced by the nuclear generator. Periodically the stored electric energy is converted into radiation impulses through an electromagnetic radiation generator which emits very high frequency radiations. The nuclear generator may be used for a beacon or for a submarine detection buoy. (F.S.)

3732 DIRECT CONVERSION OF NUCLEAR ENERGY INTO ELECTRICAL ENERGY WITH THERMIONIC ELEMENTS. Langpape, R. (Brown, Boveri u Cie. AG, Mannheim, Ger.). Waerme, 72: No. 1, 1-9 (1965). (In German).

In a thermionic element electric current is obtained directly from heat by means of the so-called thermionic effect. This thermionic effect, i.e., the fact that a hot metal emits electrons, has been known for a long time. However, only since 1959 has there been extensive development of thermionic elements. The construction and operation of these elements are briefly outlined. The efficiency of present thermionic elements is discussed. The lifetime and operational data on thermionic elements are reported. Possible uses are indicated, and their present use in connection with nuclear reactors is discussed in some detail. (J.S.R.)

14022 NUCLEAR ENERGY FOR UNDERWATER USES. Comit. Naz. Energ. Nucl., Notiz., 12: No. 8-9, 95-100 (Aug.-Sept. 1966). (In Italian).

A review of the underwater uses of nuclear energy is presented in which the possible applications of nuclear reactors and radioisotopes are discussed. (auth)

5674 NUCLEAR ENERGY FOR SPACE IN THE USSR. Veseisky, J. C. Atomwirtschaft, 11: 454-7 (Aug.-Sept. 1966). (In German).

The development of the high-temperature reactor Romaschka and of atomic batteries by the Soviet Union for space is treated. Comparisons are made with American systems. (L.B.S.)

8538 RADIOISOTOPE-POWERED NAVIGATION LIGHT. Elec. Export Rev., 5: 112 (Oct.-Dec. 1966).

A description of the U. K. Atomic Energy Authority-designed milliwatt isotope-powered generator for use in marine navigation is given. Called RIPPLE II (Radioisotope Powered Pulse Light Equipment) it is intended to power a standard marine navigation light employing a Xe flash tube to give a light visible at a range of 2 miles. It provides power for a 0.2-J flash every $3\frac{1}{2}$ sec but could be designed for any flash frequency or for applications requiring power pulses 50 times greater without exceeding 2 to 3 W mean power output rating. Models of this equipment are now being tested by various navigational bodies. The heat source in Ripple II is ^{90}Sr encapsulated in stainless steel. It is made up in the form of SrTiO_3 , which has the advantage of being insoluble in seawater, and has an activity of 700 Ci. Strontium-90's half life of 28 yr makes a 10-yr design lifetime feasible for the generator. The generators consist of an array of B_2Te_3 thermocouples each made up on a pair of bismuth-telluride-doped P and N semiconductors. These are connected in series and so arranged that heat from the source flows through each couple in parallel and into the cold sink. A compact array of thermocouple pairs has been developed which produces about 70 mW at 400 mV. A tunnel diode converter converts this output to a 6-V 30 mW dc supply for charging the storage cells. (BBB)

4620 (AHSB(RP)-M-41) ASSESSMENT OF THE EFFECTS OF RELEASES OF ACTIVITY IN THE UPPER ATMOSPHERE DUE TO POSSIBLE BURN-UP OF ISOTOPIC POWER GENERATORS. Bryant, Pamela M. (Authority Health and Safety Branch, United Kingdom Atomic Energy, Harwell (England)). Sept. 1966. 11p. Dep. mn.

The potential applications of isotopic generators as sources of auxiliary power in space involve quantities of radionuclides sufficient to produce up to 1 kilowatt (electrical) of power. As the overall rate of future failures in the upper atmosphere, resulting in burn-up of all or most of the initial activity, is likely to be low, consideration is given to the possible consequences of burn-up of a single 1 kilowatt generator fueled with any of nine nuclides selected for study. Prediction of the activity in surface air and in milk is based on data from weapons tests, and predicted activities are compared with reference levels derived for the purpose. It appears that more than ten such generators fueled with plutonium-238 or strontium-90, the nuclides which would present more potential problems than the others studied, could be burned up without the reference levels being exceeded and that only if the rate of failure involving premature or unplanned burn-up were to be much greater than the low rate anticipated would some restriction on their use in space be necessary. (auth)

Small Sources

10406 THE SELF-ABSORPTION OF AUGER ELECTRONS AND X-RAYS IN ^{54}Mn SOURCES PREPARED BY DIFFERENT METHODS. Bambynek, W.; Reher, D. (EURATOM, Geel, Belg.). Int. J. Appl. Radiat. Isotop., 18: 19-24 (Jan. 1967).

The self-absorption of the 5-keV Auger electrons of Cr emitted after ^{54}Mn decay has been determined for sources prepared by seven different methods and on four different support materials. The lowest self-absorption of the Auger electrons, i.e., approximately 2%, has been found in sources prepared by vacuum evaporation. Sources obtained by other methods such as electrodeposition, electrospraying, and simple evaporation of a drop, show about 15, 25, and 50% self-absorption, respectively. Furthermore the measured Auger electron intensities depend considerably on the roughness of the support material. A calculation using a simple model shows that in very thin sources the ratio of the self-absorption of the Auger electrons and the x rays is in a first approximation independent of the layer thickness of the source. This makes possible an estimate of the self-absorption of the x rays distinct from that of the Auger electrons; the value is found to be 0.1 to 4% depending on the method of source preparation used. (auth)

1547 METHOD OF FABRICATING ENCLOSED RADIOACTIVE PREPARATIONS WITH ^{204}Tl . Vormum, Guenther; Muenster, Hans-Juerger (to Deutsche Akademie der Wissenschaften). German Patent 1,222,591. Aug. 11, 1966. Filed Dec. 24, 1960.

A method of enclosing radioactive preparations with ^{204}Tl is described which employs a grooved base plate of copper or silver, uniformly distributed Ti_2O_3 powder in the grooves, wetting the powder with a solution of zapon varnish in acetone, reduction in hydrogen atmosphere, and enclosing the layer with a metal foil which is pressed upon the base plate at an elevated temperature. (Gmelin Inst.)

16070 (EUR-3252.f) ETUDE PRELIMINAIRE A LA MISE AU POINT D'UNE SOURCE DE NEUTRONS A BASE DE PRODUITS DE FISSION (EURATOM NEUTRON SOURCE). (Preliminary Study to the Development of a Neutron Source with a Fission-Product Basis (Euratom Neutron Source)). Godar, S.; Verfaillies, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jan. 1967. 14p. (In French). Dep. mn.

Preliminary tests relating to the use of fission products, such as ^{144}Ce - ^{144}Pr and ^{108}Ru - ^{108}Rh , for the fabrication of neutron sources are described. Judging from the results obtained, these sources have certain advantages (higher neutron flux, longer half-life and low cost) over those with a basis of ^{124}Sb . (tr-auth)

3912 INVESTIGATION OF GAMMA-RAY BACKSCATTERING FOR BROAD RADIATION BEAMS. Koch, S. (Technical Univ., Dresden). Isotopenpraxis, 2: 354-7 (Sept. 1966). (In German).

Relations between the backscattering rate and the extent and the properties of the scattering material have been studied. The measurements were carried out using the radioisotopes ^{60}Co , ^{137}Cs , ^{203}Hg , ^{141}Ce , and ^{170}Tm . The point isotropic sources have had contact with the plane boundary surfaces of the scatterers. (auth)

4183 CONSTRUCTION AND PERFORMANCE OF A SIMPLE NEUTRON SOURCE. Juliano, Jose O. (Philippine Atomic Research Center, Diliman, Quezon City); Buot, Felixberto. Philippine J. Sci., 94: 221-34 (June 1965).

A neutron source consisting of a cylindrical Fe drum completely filled with paraffin which serves as a neutron moderator and shield for fast neutrons from the $^8\text{Be}(\alpha, n)^{12}\text{C}$ reaction is described. The Pu-Be source is placed in an Al tube along the central axis. Some preliminary applications of the source to the production of radioisotopes and to activation analysis are discussed. (D.C.W.)

8391 PREPARATION OF WEIGHTLESS SOURCES OF PROTACTINIUM OBTAINED BY SPALLATION OF ^{232}Th . Briand, J. P.; Chevallier, P. (Institut du Radium, Paris), pp 321-3 of

Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

A method for protactinium extraction from a thorium target irradiated by protons of 15 to 70 MeV is described. Electrodeposition on several metals as a method for preparing weightless sources for α spectrography by means of junction detectors is briefly discussed. (auth)

21368 (CSIR-FIS-12) ABSOLUTE CALIBRATION OF TWO AMERICIUM-BERYLLIUM NEUTRON SOURCES. Steyn, J.; Thilo, L. R.; De Jesus, A. S. M. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab.). Oct. 1965. 17p. Dep. mn.

The emission rates of two americium-beryllium neutron sources were measured by the manganous sulphate bath method and were found to be: $327 \pm 0.066 \times 10^6$ neutrons per second for source NPRL N-1, which was supplied by The Radiochemical Centre, Amersham, and $1.614 \pm 0.017 \times 10^6$ neutrons per second for source Am N-116 which was lent by the National Research Council, Ottawa, for intercomparison. Measurements made by the NRC and the NPRL on the emission rate of source Am N-116 agreed to within 1%. (auth)

8553 IMPROVEMENTS IN OR RELATING TO RADIOACTIVE SOURCES. Faïres, Ronald Arthur. (to United Kingdom Atomic Energy Authority). British Patent 1,050,418. Dec. 7, 1966. Filed June 17, 1964.

A soluble low activity radioactive source is described in which ^{22}Na , ^{32}P or ^{131}I is used as the source material. The source is a tablet of a soluble inactive carrier with a soluble compound containing a radioisotope deposited on it. The inactive carrier contains an inactive isotope of the source material chemically combined in the same manner as the radioactive isotope. The activity of the source is less than 1 mCi and not more than 10 μCi . (F.S.)

5975 MOLECULAR PLATING. V. THE INFLUENCE OF SOME EXPERIMENTAL FACTORS ON THE DEPOSITION YIELD. Getoff, N.; Bildstein, H.; Proksch, E. (Selbersdorf Reactor Center, Vienna). Nucl. Instrum. Methods, 46: 305-8 (1967).

The effects of cathode diameter, electrode distance, initial current, and temperature on the deposition yield using the molecular plating method were studied. $^{90}\text{Sr}/^{90}\text{Y}$ was used as a model nuclide. The best conditions to obtain a uniform layer with 100% yield are reported. (auth)

5983 PREPARATION OF RADIOACTIVE SOURCES BY ELECTRODEPOSITION FOR ALPHA SPECTROMETRY. Acena, M. L. (Junta de Energia Nuclear, Madrid). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/40, 10p. (In Spanish). (CONF-661012-5). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

A process is described for preparing radioactive sources with low self-absorption by electrodeposition on a cathode of polished refractory steel. Operations are carried out with a total volume of about 5 ml of a 2.5M NH_4Cl electrolyte at a pH ~ 1 in a specially designed Al and plexiglass cell. A piece of teflon limits the deposition surface on the cathode. A Pt anode 1.7 cm in diameter is rotated by means of a synchronous motor at 600 rpm at a distance of 0.5 cm from the cathode. Appreciable electrodeposition yields were obtained in operations carried out with a cathode current density of 870 $\text{mA}\cdot\text{cm}^{-2}$ produced by an electrode voltage of 8 to 10 V and a maximum time of 30 minutes. This technique was used to prepare sources of enriched uranium containing 0.78% ^{234}U , 90.2% ^{235}U , 0.33% ^{236}U , and 8.69% ^{238}U , as well as sources of ^{238}Pu + ^{240}Pu , ^{232}Th + ^{230}Th , and ^{241}Am . The activities of the sources varied between 10 and 50,000 dpm and adhesion and homogeneity characteristics were excellent. Appreciable deposits of these same elements were also obtained by using solutions containing all the elements. This provides a good method for carrying out quantitative determinations of mixtures of these α emitters. With the help of these sources it was possible to obtain different α spectra by using silicon barrier detectors together with a pulse height analyzer. No loss in resolution as a result of self-absorption was detected in the spectra peaks and no low energy tail was found. (auth)

4588 REFERENCE SPECTROMETRIC ALPHA SOURCES. Aleksandrov, B. M.; Belyatskii, A. F.; Berkovich, I. B.; (and others). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/75, 30p. (In Russian). (CONF-661012-7). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

A method was developed for the fabrication of 21 different types of reference alpha sources with both one and a mixture of different isotopes and for determining the basic physical characteristics of spectrometric sources in which the following isotopes are used: ^{238}U , ^{235}Pu , ^{241}Am , ^{238}Pu , ^{244}Cm , ^{242}Cm , and ^{230}Th . These reference sources are designed for calibrating semiconductor alpha spectrometers and other spectrometric and counting apparatus. The alpha particles emitted by the source have a small energy scatter. The sources fall into three categories, depending on the "intrinsic half-width of the alpha lines": up to 10 keV, 10 to 20 keV, and 20 to 50 keV. Most of the sources fall into the first two categories. The energies of the alpha particles emitted by the reference sources were determined to within 2 to 5 keV. With the help of a precision magnetic alpha spectrometer, the shape of the alpha lines was investigated in the process of developing the method of manufacturing the source, and a constant check was kept on the energy shift of the alpha lines due to self-absorption and to energy losses from the film coating. The activities of the reference sources lie within the range $3 \times 10^2 - 3 \times 10^5$ disintegrations per second and are determined to within 2 to 4%. In most of the reference sources the layer of radioactive substance is firmly attached to the base, and in a number of cases covered by a film. The base consists of a metallic disc (diameter 24 or 35 mm, thickness 1 mm). The diameter of the active spot is 12 mm. The fabrication process is also applicable to reference sources including ^{210}Po , ^{226}Ra , and ^{227}Ac sources. (auth)

5984 PREPARATION AND CALIBRATION OF ALPHA-ACTIVE SOURCES OF THE ACTINIDE ELEMENTS. Glover, K. M. (Atomic Energy Research Establishment, Harwell, Eng.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/39, 16p. (CONF-661012-10). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Methods used for the preparation of standard α sources in the range from 0.001 μCi to 1 mCi are vacuum sublimation and electroplating. Vacuum sublimation is preferred since uniform films giving the required resolution of <20 keV full width half maximum peak height (FWHM) are consistently obtained. However, the effi-

ciency of this method for a 1 to 2-mm diameter source is only about 1% and electro-spraying with an efficiency of 75% is preferred for those actinide nuclides of which only milligram or lesser quantities are available. The instruments used to calibrate α sources include a low-geometry proportional counter, used to measure the absolute disintegration rates of sources in the activity range from 0.1 μ Ci to 1 mCi with an accuracy of $\pm 0.2\%$, whereas for sources of less than 0.1 μ Ci the accuracy obtainable is of the order of 1%. The individual α -emitting nuclides present in a mixed α source can be assayed quantitatively to an accuracy of 1% with a suitable detector and ancillary electronic equipment, assuming that the peaks are well resolved. For high-resolution α spectroscopy measurements, a gridded ion chamber with a resolution of 25 keV FWHM is used for large sources and activity levels of less than 0.01 μ Ci, but for sources of activity >0.1 μ Ci, a Si-Au surface barrier detector chamber capable of giving a resolution of at least 15 keV FWHM is used. To overcome the problem of gaseous daughter products a low-geometry counter with a solid-state detector is being developed. (auth)

4586 PREPARATION OF POINT SOURCES OF β -EMITTERS FOR THE IRRADIATION OF TISSUE CULTURES. Babicky, A.; Liebster, J.; Lodin, Z.; Chromec, Ch.; Linhart, J. (Inst. for Biological Research, Prague Inst. of Physiology, Prague). *Int. J. Appl. Radiat. Isotopes*, 17: 662-3 (Dec. 1966).

Two methods were used for the preparation of point sources of β -emitters for the irradiation of tissue cultures. ^{32}P was prepared by adsorption of the carrier-free radioisotope from a solution of $\text{Na}_2\text{H}^{32}\text{PO}_4$ by ion-exchanger grains. A ^{90}Sr - ^{90}Y solution was used in the preparation of ^{90}Sr . ^{90}Y was precipitated in a capillary. (J.G.R.)

12831 (CMN-Pub-2/65) BASES BIOLOGICAS DA RADIO-ISOTOPIA E NOCOES DE HIGIENE DAS RADIACOES. (Biological Bases for Radioisotope Use and Concepts of Radiation Protection). Rapp de Eston, Veronica; Eston de Eston, Tede; Bitelli, Thomaz (Sao Paulo Univ. (Brazil). Centro de Medicina Nuclear). 1965. 129p. (In Portuguese). DTIE.

The basic concepts in the use of radioisotopes in medicine are reviewed in a series of articles on the somatic effects of radiation, radiation protection, maximum permissible levels, radiation detection, and radiation protection. Laboratory experiments to familiarize students with the use and dangers of radioisotopes are included. (J.S.R.)

393 PUBLIC HEALTH ASPECTS OF THE MEDICAL USES OF IONIZING RADIATION. Report on a Seminar Convened by the Regional Office for Europe of the World Health Organization, Lund, 4-9 October 1965. Copenhagen, Regional Office for Europe, World Health Organization, 1966. 48p.

The hazards to patients and medical personnel of exposure to ionizing radiations used for medical purposes are reviewed. The somatic, genetic, and leukemogenic effects of radiation are discussed and recent improvements in techniques and equipment leading to decreased exposure during dental and diagnostic radiography and radiotherapy using x radiation, γ radiation, and sealed or unsealed radioisotopes are considered. Public health and legal aspects of radiation protection are also considered briefly. (C.H.)

4795 (NP-16352) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 3, Number 5. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). May 1965. 34p. Dep. mn.

I. A report is given on the safety of radioisotopes in industry. Data are presented on the rate of increase of uses of radioisotopes as measured by the number of new radioisotope licenses and license amendments issued in Canada over recent years. Additional data on the number of radiation accidents which have occurred in Canada over the same period are presented. There has been no significant change in the number of over-exposures over the years in spite of the increased use of radioisotopes. II. Canadian fallout data for April, 1965, are given. Data on air, precipitation and milk are tabulated. The air data are given in terms of gross beta activity per cubic meter of air. Tables are given to show the total

10554 LOW-ENERGY β -RAY SOURCE. Miwa, Hirohide (to Kobe Kogyo Corp.). Japanese Patent 1966-3199. Feb. 23, 1966. Filed Nov. 9, 1964.

An improved, low-energy β source is described. A high-energy β source is placed in the β shielding container whose window is sealed with a protective foil permitting the passage of β particles. This source container, in turn, is placed in the outer protective container with an irradiation window, whose inside surface has a β scattering layer. The high-energy β particles impinge upon the scattering layer, and the resulting (secondary) low-energy β particles are taken out through the irradiation window for irradiation purposes. (NSA of Japan)

14395 USE OF A WEIGHTLESS SOURCE TO DETERMINE SELF-ABSORPTION IN THIN BETA SOURCES. Denisikov, A. I.; Dorofeev, G. A.; Sobolev, Yu. P. Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/73, 8p. (In Russian). (CONF-661012-33). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

A method of determining self-absorption in a thin beta source by comparing its activity with that of a "weightless" source is described. The technique presented is for determining self-absorption for ^{60}Co sources. (auth)

12606 GAMMA RADIATION SOURCE. (to General Electric Co.). British Patent 1,056,565. Jan. 25, 1967. Priority date Feb. 6, 1963, United States.

A radiation source is described which produces γ radiation by a stimulated-emission photon chain reaction. A relatively stable isotope ^{68}Zn is used and is prepared by the neutron irradiation of a ^{68}Zn target. (F.S.)

SAFETY

beta activity per square kilometer in precipitation and the strontium-90 and cesium-137 concentrations in precipitation. Strontium-90 and cesium-137 determinations on milk samples are tabulated.

III. Reactor environment monitoring data for April, 1965, are given. Total alpha activity and total beta activity in water samples are tabulated. Results of analysis of water samples for strontium-89, strontium-90 and cesium-137 are also tabulated. Total beta activity measurements on air filter samples in proximity to the McMaster University reactor are tabulated. (H.L.W.)

14360 (RT-ING-(66)-8) SAFETY ASPECTS OF IRRADIATION EXPERIMENTS. Gerosa, A.; Moretti, S. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 10p. Dep. mn.

A general method of dealing with the safety aspects in designing and testing irradiation devices is proposed. The safety analysis should be made on a rational quantitative basis, taking into account economic factors and failure probabilities. The method of analysis can also be applied in nonnuclear fields. (auth)

3335 SAFETY DEVICE FOR THE DETECTION OF DAMAGES OF A RADIOACTIVE SOURCE MOUNTED IN DEVICES FOR THE MEASUREMENT OF DENSITY OR THICKNESS. Schuetz, Gerhard; Selmann, Hans (to VEB Vakutronik Dresden). German Patent 1,225,781. Sept. 29, 1966. Filed Dec. 2, 1963.

A safety device, which consists of a radiation transparent, spring-loaded disc located between the radiation source which is attached to a chassis, and the material to be measured is described. The disc is moved automatically by the spring force on touching, thereby actuating an electrical contact which releases an alarm signal. (Gmellin Inst.)

10442 PROCESS AND APPARATUS FOR THE CONCENTRATION OF RADIOACTIVE SOLUTIONS OR LIQUIDS. Charuit, Pierre; Wormser, Gerald (to Commissariat l'Energie Atomique). U. S. Patent 3,280,887. Oct. 25, 1966. Priority date Apr. 4, 1962, France.

An apparatus is described for the concentration of liquids, particularly radioactive ones, by natural evaporation. The apparatus includes a reservoir for receiving the liquids, a dividing chamber positioned above the reservoir and containing a number of vertically disposed dividing plates mounted within the chamber. The components are so arranged that the liquids flow from the top to

the bottom. Conduit means including a pump are provided for conveying the liquids from the reservoir to above the dividing plates and from the bottom of the dividing plates to the reservoir. An expansion chamber above the dividing chamber has a section substantially larger than that of the dividing chamber. A hollow, converging, open ended truncated cone connects the dividing chamber with the expansion chamber, and the expansion chamber has an exit orifice having a section at least as great as the minimum section of the cone. First and second means are provided to circulate air through the dividing chamber in an upward direction with the second fan being mounted at the exit orifice of the expansion chamber. (B.L.M.)

Manuals

16335 (CMN-Pub-4/65(Vol.1)) **MANUAL DE HIGIENE DAS RADIACOES E PROTECAO RADIOLOGICA.** (Manual of Radiation Hygiene and Biological Protection). Bitelli, Thomaz (Sao Paulo Univ. (Brazil). Centro de Medicina Nuclear). 1965. 185p. (In Portuguese). DTIE.

A manual of radiation hygiene and radiological protection written for radiologists, scientists, and technicians using radioisotopes or x rays in medical, physical, chemical, or industrial areas is presented. In the first volume the types of radiation and the fundamentals of radioactivity are outlined. The radiation units are defined. The interaction of radiation with living cells is described in some detail. The design of laboratories using radioisotopes is considered. The detection of radioisotopes and the dilution of radioactive liquids are also considered. (J.S.R.)

12750 (STI-DOC-10/60) **LABORATORY TRAINING MANUAL ON THE USE OF ISOTOPES AND RADIATION IN ANIMAL RESEARCH.** Technical Reports Series No. 60. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1966. 196p. IAEA \$4.00; S 84,-; Pound 1.4,0; F Fr 16,-; DM 14,-.

This manual contains lecture material and laboratory exercises applicable to a basic course on the use of isotopes and radiation in animal research. Basic concepts of nuclear physics, radiation detection, and health physics are discussed and applications of the basic principles are discussed. Eighteen laboratory exercises are given to illustrate the use of various radiation detection instruments; 13 others cover tracer studies in rats, dogs, and frogs; and one shows the acute effects of radiation on rats. The material is well organized and each section is followed by a bibliography. The appendices present information pertinent to the studies. (C.H.)

11008 (STI-DOC-10/61) **LABORATORY TRAINING MANUAL ON THE USE OF ISOTOPES AND RADIATION IN ENTOMOLOGY.** Technical Reports Series No. 61. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1966. 144p. IAEA \$3.50; S 73,50; Pound 1.1,0; F Fr 14,-; DM 12,25.

General and basic information encompassing the properties of radioisotopes and radiations, the methods of radiation detection, the application and uses of the basic properties of radioisotopes and radiations, and the precautions and procedures necessary for the safety of the individual in the use of radioisotopes and radiations are presented in lecture form. Introductory laboratory experiments are outlined for the use of a Geiger-Muller counter and for the procedure used in evaluating results obtained with the instrument. Exercises designed to familiarize the student with the use and uses of the scintillation counter in regard to crystal scintillation counting, rapid radioactive decay, liquid scintillation counting, and the inverse square law: attenuation of gamma rays are also presented. Another section of laboratory exercises are designed to introduce the student to the supplementary basic principles involved in localization, isotope dilution, tracer kinetics, activation analysis, neutron scattering, and gamma attenuation. An extensive applied section outlines experiments designed for use of radioisotopes and radiation in entomology. Experiments include methods for study of metabolism of ^{14}C -malathion, ^{14}C -DDT, ^{14}C -aldrin, and ^{32}P -labelled systemic insecticides using bio-assay in conjunction with radio-assay; detection of penetration of H_3 -labelled insecticides through and into insect cuticle; determination of insect host plant preferences, movement of subterranean insects, insect dispersion, speed of flight and total numbers of insect populations; demonstration of food exchange and transfer of glandular secretions among social insects; demonstration of radiation dosages required to produce sterility in insects, the effect of radiation on the reproductive potential of male and female insects, effect of anoxia on radiation sterilization, and the effect of radiation on insect chromosomes; and use of autoradiography as an entomological technique. (B.H.S.)

12867 **LEGAL SOURCES OF RADIOPROTECTION.** Pfaffelhuber, Josef (Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg, Ger.). Radiologe, 6: 338-42 (Aug. 1966). (In German).

The legal background on which the authority of the German Federal Republic is based to control and regulate use of atomic energy and radioisotopic drugs is discussed. These laws as issued control the limit of tax-free income for nuclear fuels, precautions, import and export of radioactive materials, general licensing exemptions, and licensing of various types of construction. The degrees to which various portions of the legal regulations overlap, as between the Federal Republic and the several states, and the respective legal powers of each unit to regulate the licensing and use of atomic energy and radioisotopes are outlined briefly. Other legal considerations that affect use and distribution of radioisotopes are defined and evaluated. (BBB)

20464 **THE TECHNICAL BASIS FOR LEGISLATION ON IRRADIATED FOOD.** Report of a Joint FAO/IAEA/WHO Expert Committee, Rome, 21-28 April 1964. World Health Organ., Tech. Rep. Ser., No. 316, 1-56(1966).

This committee considered available evidence on the effects on food of treatment with ionizing radiation and made recommendations on the general principles under which the production and use of irradiated food may be permitted and the procedures that should be adopted for the evaluation of the wholesomeness of irradiated food. Committee personnel included experts in food technology, packaging, biochemistry, microbiology, public health, pharmacology, toxicology and radiation technology. (C.O.)

21825 (EUR-3127.e) **ELEMENTS OF A THIRD-PARTY LIABILITY INSURANCE CONTRACT FOR OPERATORS OF FIXED NUCLEAR INSTALLATIONS.** Euratom Skeleton Third-Party Liability Policy in Respect of Installations. (European Atomic Energy Community). Aug. 12, 1966. 20p. Dep. mn.

The Euratom skeleton insurance policy is the result of cooperation between the Euratom Commission and the nuclear insurers, nuclear industry organizations, and electricity producers in the Community. It contains the elements of a nuclear third-party liability insurance contract. In view of the increasing unification of the nuclear industry in the Community, a standardization of the main clauses in this branch of insurance is recommendable. The skeleton policy is based on the provisions concerning liability in the Convention on Third-Party Liability in the Field of Nuclear Energy dated 29 July 1960 (Paris Convention) and the Supplementary Convention dated 31 January 1963 (Brussels Convention). (auth)

Transportation

6125 **IMPROVEMENTS IN OR RELATING TO CONTAINERS FOR TRANSPORTING RADIOACTIVE MATERIALS.** Dixon, Frank Edward; Partridge, Albert Henry (to United Kingdom Atomic Energy Authority). British Patent 1,048,967. Nov. 23, 1966. Filed May 4, 1964.

A container which minimizes the effect of heat and accidental damage in transporting radioactive materials is described. The container consists of an inner lead vessel with a cavity 1.036 in. in dia and 2.5 in. deep with a wall thickness of 1.5 in. The lead vessel is closed by a spigoted lid. The lead vessel is hermetically enclosed within a close fitting mild steel canister with a lid rim which seals to the top when closed. The canister is thermally insulated by a number of discs and annular rings which surround and centrally locate the canister in an outer drum of 20 gauge MS steel 10 in. ID and 13½ in. high. The drum is fitted with a standard type closure lid. Drilled holes in the top provide pressure release in case of fire. Mild steel patches are soft soldered over the holes. The entire container weighs 10 lbs. The container is suitable for transporting 5 Ci of ^{132}I . (F.S.)

6168 (TRG-Report-1287) **ESTIMATION OF THE ACTIVITY CONTENT IN CURIES OF RADIOACTIVE MATERIALS FOR TRANSPORT PURPOSES.** Shaw, A. E. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). July 22, 1966. 37p. Dep. BIS \$1.10. HMSO 5s. 6d.

The problems that arise when it is required to estimate the curie content of radioactive materials to be transported under the auspices of regulations such as have been put forward by the International Atomic Energy Agency are reviewed. Estimations by calculation and from external radiation measurements are discussed, and some of the practical uncertainties that arise in each case are explored. The general conclusion is that the estimate of curie content is not very precise. (auth)

12564 TRANSIT FLASK FOR RADIOACTIVE OBJECTS. Brebant, Charles (Commissariat à l'Energie Atomique). British Patent 1,055,818. Jan. 18, 1967. Priority date Dec. 6, 1963, France.

An air-tight shielded container used to protect and transport radioactive objects such as irradiated fuel elements, is described. It consists of a high-density metal casing forming an outer cover for the shielding material. The casing has at least one pocket bounded by a deformable fusible Pb-Sb metal alloy sheet which liquifies at a predetermined temperature and escapes through a Pb-Bi plug forming an expansion volume for the shielding material. (F.S.)

6507 SHIELDED CONTAINER FOR CARRYING AND DISPENSING DOSES OF RADIOISOTOPES FOR INTRAVENOUS USE. Bell, T. K.; McKittrick, N. (Royal Victoria Hospital, Belfast). J. Med. Lab. Technol., 22: 226-7 (Oct. 1965).

A lead pot of $2\frac{3}{4}$ in. OD and walls $\frac{1}{2}$ in. thick, which surrounds columns of ^{132}Te received in the lab from the supplier, forms the basic part of the container which is designed to accommodate bijou bottles of 6-ml capacity. The pot, which has a lid $\frac{1}{2}$ in. thick, is reduced to $3\frac{1}{2}$ in. high and two slots $1\frac{1}{4}$ in. long and $\frac{1}{4}$ in. wide, directly opposite each other are cut in its surface $3\frac{1}{8}$ in. from the bottom. A hollow cylinder of lead, $2\frac{1}{2}$ in. long and walls $\frac{1}{4}$ in. thick inserted in the container, is kept in place by two screws which hold an aluminum handle for carrying the dispenser. The bijou bottle is supported at the bottom by a plastic sponge and is surrounded by a cylinder of cardboard to minimize mechanical shock. The metal top of the bottle is perforated by a $\frac{3}{16}$ in. dia hole near the edge and the radioactive solution retained by a rubber bung. The container is held in the inverted position by a retort stand and clamp when dispensing the doses and the bottle is kept in place by an L-shaped piece of lead $3\frac{1}{2}$ in. long and $\frac{1}{4}$ in. thick placed in the slots. A hole in this L-piece $\frac{5}{16}$ in. dia centered on the hole in the top of the bijou bottle allows it to be cleaned before removing the radioactive doses with a syringe. The container, which may be used for carrying and dispensing tracer doses of ^{131}I labeled substances for renal function and cerebral blood flow studies, attenuates the γ radiation emitted by this isotope by over 95%. Unused doses may be resterilized by placing the whole container in an autoclave without removing the bottle. (BBB)

Structures

6170 PETRUS, HOT CELL FOR ^{252}Cf . Sontag, R.; Berger, R. (Commissariat à l'Energie Atomique, Fontenay-aux-Roses, France). Trans. Amer. Nucl. Soc., 9: 615 (Oct.-Nov. 1966).

10515 VENTILATION OF RADIOACTIVE LABORATORIES. Barrachina, M. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 10: 311-22 (July-Aug. 1966). (In Spanish).

Some general considerations on the ventilation of laboratories are discussed and the requirements for the ventilation of radioactive laboratories are given. The ventilation facilities of an existing radioactive laboratory are discussed in detail. The equipment and materials used for this installation are described. A summary of the specifications is given. (G.O.Y.)

10563 CABIN FOR THE HANDLING OF RADIOACTIVE MATERIALS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,051,217. Dec. 14, 1966. Priority date Mar. 8, 1963, Germany.

A cabin used in handling radioactive materials is described. Walls of the cabin shield a worker from radioactivity. Means for moving the cabin over a horizontal surface, as desired, is provided. A fan and blower system is also provided which allows the cabin to move, like a hover craft. Air conditioning and pressurization means are provided. Air tight gloves or externally mounted manipulators which can be actuated mechanically, electrically, or hydraulically from inside the cabin allow the occupant of the cabin to handle radioactive materials located outside the cabin. The cabins are removed through a decontamination area to ensure the protection of the occupants of the cabin. (F.S.)

19822 RADIATION PROTECTION DRY WINDOWS FOR HOT CELLS. Jahn, Walter (Brunke Garrels Verlags-buchhandlung, Hamburg). Glas-Email-Keramo-Tech., 17: 130-3 (Apr. 1966). (In German).

Hot cells, in which fuel elements are examined, or split, or in which radioactive isotopes are chemically converted, are a part of nuclear research centers and isotope laboratories. In order to achieve a sufficient shielding of the high gamma doses (max. 10^4 to 10^5 Curie), considerable wall thicknesses of the hot cells are necessary. Concrete walls 1 meter thick and more are not unusual. The radiation shielding windows built into the hot cells have relatively large viewing openings corresponding to these wall thicknesses. The windows of such dimensions are composed of several thick glass blocks. (tr-auth)

1493 DESIGN OF LABORATORY BUILDINGS FOR WORKING WITH RADIOACTIVE SUBSTANCES. Shchukin, V. P. Sb. Tr. Mosk. Inzh.-Stroitel. Inst., 41: 45-63 (1962). (In Russian).

The problems facing the architect-engineer who designs buildings for handling highly radioactive materials while protecting the workers against radiation injury, are reviewed. Both research laboratories and pilot plants are considered. The cases that must be taken into account include protection against ionizing radiation, radioactive contamination, and the combination of these two cases. In addition to the protection of personnel, shielding must be provided for some of the more sensitive instruments. Actual design of the building depends on the health-physics regulations in force, the branch of science to be served and the intended function of the building, such as research, education, etc., and the equipment to be installed. In structural calculations, the required shielding materials, such as heavy concrete, special metals, etc., must be taken into consideration. Whether a hot laboratory should be placed in an isolated portion of a building or be made into a separate building depends on other factors, including convenience of operation and construction costs. Floor plans and elevations of various existing hot-cell blocks and canyons are presented, pointing out the advantages and the shortcomings of specific solutions. (TTT)

17795 APPARATUS FOR SHIELDING AND EXPOSING A RADIOACTIVE SOURCE. Corfa, Yves; Jossoud, Michel; Pelegrin, Pierre; Vertut, Jean (to Commissariat à l'Energie Atomique). British Patent 1,063,726. Mar. 30, 1967. Priority date Apr. 7, 1964, France.

An apparatus is described which is used in an irradiation facility for shielding and exposing the radiation source when the substance to be irradiated moves as a screen or curtain between or around the source. A control system provides the required level of irradiation needed. Conduits are provided to bring the material to be irradiated from storage, move it past the source, and return it to storage. (F.S.)

Handling Devices

1546 POWER MANIPULATOR. Tsuda, Eiichi; Shikata, Sanji (Mitsubishi Electric Mfg. Co., Ltd., Japan). Mitsubishi Denki Gihō, 40: 1182-7 (July 1966). (In Japanese).

Electrically operated remote control equipment for handling radioactive materials, built for the purpose of operating inside a large hot cave to manipulate heavy articles is described. The equipment was manufactured by the Atomic Energy Establishment in Trombay, India and shipped to the destination in July 1965. The power manipulator and an electric hoist are set up on the same gantry for ease of handling the control cables and a large operating space. It has a selective call device with which a number of control signals are sent over one cable in operation. (NSA of Japan)

12881 DISPENSER FOR FREE-FLOWING RADIOACTIVE SUBSTANCES. Barsukov, B. N. Med. Radiol., 11: No. 10, 43 (Oct. 1966). (In Russian).

A device was designed for dispensing free-flowing radioactive substances. Radioactive preparations are conveyed from storage to delivery by a worm conveyer. The entire system is encased in lead shielding. A radiometric device is used to apportion preparations. (BBB)

16059 SYSTEM FOR DISTRIBUTING SAMPLES. Galame-Longjean, Andre; Guillet, Henri (to Commissariat à l'Energie Atomique). British Patent 1,059,903. Feb. 22, 1967. Priority date Mar. 6, 1964, France.

A system is described which is used in distributing samples, particularly radioactive samples, whose contact with the atmo-

sphere might be harmful to the samples or to the operators. The system consists of a central elevated casing adapted to receive the samples which are in polythene vials. The vials are transferred by gravity from the central casing in tubular conduits to the glove box for analysis. The samples are then sent to a receiving basket to be raised later into the central casing. (F.S.)

MISCELLANEOUS

1572 (BNL-tr-88) ON THE FEASIBILITY OF USING GALLIUM AS A SOLAR NEUTRINO DETECTOR. Pomanskii, A. A. (Akademiya Nauk SSSR, Moscow, Institut Fiziki). Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from a report. 21p. Dep. mn. CFSTI \$1.00 cy, \$0.50 mn. JCL \$2.00 fs, \$0.83 mf.

The study of the feasibility of gallium as a solar neutrino detector includes the problem of extracting germanium from gallium after the reaction $\nu + {}^{71}\text{Ga} \rightarrow {}^{71}\text{Ge} + e^-$ and the various background processes of ${}^{71}\text{Ge}$ formation. From the analysis it is evident that the use of gallium as a detector of solar neutrinos presents no serious difficulties. The most difficult problems are the development of a low background counter for the registration of the decay of radioactive germanium-71 and a total purification of germanium extracted from arsenic. (J.F.P.)

129 METHOD FOR ANTISTATIC TREATMENT OF FABRICATED ARTICLES OF α -OLEFIN POLYMERS.

Ueno, Jiroo (to Sekisui Chemical Co., Ltd.). Japanese Patent 1965-21150. Sept. 20, 1965. Filed June 30, 1962.

A method is proposed for antistatic treatment of fabricated articles of α -olefin polymers. An antistatic quality of long durability can be obtained for α -olefin polymers such as polyethylene and polypropylene. A thin film of silicic acid or silica is attached on the surface of the articles of α -olefin polymers, after which they are irradiated with ionizing radiation in contact with acrylonitrile. (NSA of Japan)

4807 RADIATION SOURCES AND LIGHTNING. Lancet, 1: 1198-9 (May 28, 1966).

The possibility that ionization of air produced by radiotherapy devices, for example, ${}^{60}\text{Co}$ sources, may predispose toward lightning strikes is discussed in relation to a new type of lightning rod tipped with radioisotopes. The claim is made for these rods that the ionization produced by the source (usually of radium or americium) will enhance the conducting power of the surrounding air and therefore improve the effectiveness of the device. It has been calculated that the ionization produced by a typical commercial installation of this kind, at the distance of 100 m to which protection is claimed to extend, is less than 1% of that associated with the natural radiation background. It is observed that a kiloCurie source of ${}^{60}\text{Co}$, as commonly used in radiotherapy, will give a much greater amount of ionization at 100 m, which introduces the possibility of a lightning hazard to radiotherapy departments. However, it is believed that no such hazard exists. The assertion that a lightning conductor can be made more effective by the addition of a radioactive source is unsupported by convincing experimental or statistical evidence. Moreover, there is reason to believe that the radioactive attachment will have no effect whatever. It is pointed out that hot gases escaping from a chimney are appreciably ionized, but hot and cold chimneys appear equally liable to lightning damage. The exhaust gases from an airplane are an even richer source of ions, but lightning damage to the exhaust system is very uncommon. A properly designed lightning conductor of the traditional Franklin type, with or without a radioactive pinnacle, is adequate for any building. It is suggested that there is no need for radiotherapists to shut off their machines during a thunderstorm. (BBB)

5931 MECHANICAL HARDENING OF ROCK SALT WITH γ RADIATION. Gorski, Walter; Heller, Siegfried (Max-Planck-Institut fuer Experimentelle Medizin, Goettingen, Ger.). Z. Naturforsch., 21a: 1522 (Sept. 1966). (In German).

Samples of rock salt were exposed to γ radiation from a 5000 C source for 8.16, 81.6, and 816 hrs. The hardness was determined in Vickers numbers and compared with the results obtained from x radiation. The hardness increased with irradiation time, but x radiation gave higher hardness values. (J.S.R.)

3136 RADIOLUMINESCENCE FROM β -RADIATION OF ${}^{147}\text{Pm}$. Serra, Maria (Univ., Rome). Ric. Sci., 36: 662-4 (July 1966). (In Italian).

A technique for producing a luminous source excited by β radiation from ${}^{147}\text{Pm}$ is described; activities employed reached up to 2000 mCi. The equipment used is described. (auth)

3221 ADVANCES IN THE PRODUCTION OF RADIOACTIVE LUMINESCENT PAINTS. Wahl, Reinhold. Z. Instrumentenk., 71: 130-3 (May 1963). (In German).

A measurable proportion of the background radiation of the population may originate from luminous watch dials bearing radium. Developments in luminous paint now make it possible to eliminate γ radiation exposure from this source. A review of progress in this field shows that in the production of luminescent paints, other materials with induced radioactivity can be used instead of radium. At present, the β rays of promethium-147 and tritium can be successfully used for the activation. Besides the advantage of the dose of radiation being smaller, the β rays destroy the light centers stimulating the luminescence much less than the α rays used until now. Therefore, a higher light intensity can be produced. On the basis of energy, half-life period, time it remains in the body, extent of dose, and other qualities, tritium offers favorable properties for activation of luminous paints, especially as compared with radium. (BBB)

10719 ELECTROCHEMICAL CELL WITH DIRECT CONVERSION OF IONIZING RADIATION INTO ELECTRIC ENERGY.

Zagorski, Zbigniew Pawel (Inst. of Nuclear Research, Warsaw); Panta, Przemyslaw Piotr. Nukleonika, 11: 681-3 (1966).

A cell was developed in which ionizing radiation develops a potential difference and thus generates electric energy. The cell comprises a sandwich or coil of 50- μ Al foil electrolytes separated by 100- μ layers of semiliquid electrolyte (ammonium glycol borate in ethylene glycol). The behavior of the cell upon irradiation depends on the resistance of the external circuit; if it is low, a current is produced which stops upon interruption of the irradiation. Analogies and possible dosimetric applications are discussed. (D.L.C.)

5823 METHODS OF RADIOACTIVITY METROLOGY IN THE USSR. Karavaev, F. M.; Konstantinov, A. A.; Kholnova, E. A.

(Mendelev All-Union Scientific Research Inst. of Metrology, Leningrad). Vienna, International Atomic Energy Agency, 1966. Preprint No. SM-79/68, 16p. (In Russian). (CONF-661012-12). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Methods and apparatus presently used in Soviet metrology laboratories for accurately measuring the specific activity of reference radionuclide solutions and the activity of radioactive sources of different types are reviewed. The primary standards made and used at the Mendelev Institute of Metrology for reproducing the activity unit of radionuclides (natural and artificial) in radioactive sources over a wide range of activity unit values and for different kinds of radioactive decay: assemblies with 4 π counters of different dimensions, an assembly for counting 4 π β - γ and β - γ coincidences, and assemblies with gamma calorimeters (of the static and adiabatic types) and ionization chambers are described. The methods and apparatus for transferring the measurement of the activity unit from the standards to the radioactive sources and measuring instruments (alpha and beta radiation meters) used in practice, control units, measuring techniques, and reference alpha, beta, and gamma sources, are described. The control circuit that regulates the order in which the transfer is effected is also discussed. (auth)

5912 APPLIED RADIATION CHEMISTRY. Black, R. M. (British Insulated Callender's Cables Ltd., London). Rep. Progr. Appl. Chem., 50: 144-58(1965).

Recent progress is reviewed under the following headings: introduction, crosslinking of polymers, polymerisation of monomers, graft co-polymers, preparative radiation chemistry (chemo-nuclear processes), and radiation damage and protection. (UK)

12701 IMPROVEMENTS RELATING TO SCINTILLATION APPARATUS FOR THE EXAMINATION OF MATERIAL. Shemmans, Malcolm John; Wycherley, John Ralph; Townend, Gordon Howard (to G.K.N. Group Services Ltd.). British Patent 1,052,262. Dec. 21, 1966. Filed Aug. 30, 1962.

A scintillation apparatus is described for examining various materials, comprising of the combination of a source of penetrating radiation directed along a path and a screen, composed of light transmitting material loaded with a scintillating medium, which is separated from the source for detecting the radiation. The materials to be examined are inserted between the source and detector. (B.G.D.)

12444 (NP-tr-1480) A PRACTICAL COURSE IN RADIATION CHEMISTRY. Bugaenko, L. T.; Kalyazin, E. P.; Saraeva, V. V. Translated by J. M. Crabtree and J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from pp 2-162 of Praktikum po Radiatsionnoi Khimii, Izd. Mosk. Gos. Univ. im M. V. Lomonosova, Moscow, 1962. 147p. Dep. mn. CFSTI \$3.00 cy, \$0.65 mn, JCL \$11.00 fs, \$4.61 mf.

A collection of experiments on the basic aspects of radiation chemistry is presented, involving the use of x-ray apparatus as a source of ionising radiation, although ^{60}Co gamma radiation may be used with appropriate changes in irradiation conditions. Topics covered include: dosimetry in radiation chemistry, radiation chemical changes in aqueous solutions, aqueous solutions of organic substances, radiolysis of organic compounds, radiation-chemical oxidation of organic compounds, and radiation chemistry of polymers. (UK)

10665 CHECKING PERFORMANCE OF NUCLEONIC APPARATUS WITH SHORT-LIVED ISOTOPES. Marais, P. G.; Karsten, J. H. M.; van R. Smit, J. (Fruit and Food Tech. Research Inst., Stellenbosch, S. Afr.). S. Afr. J. Agr. Sci., 9: 491-4(1966).

Radioactive decay affords an excellent means of checking the performance of nucleonic apparatus, by taking successive measurements during the decay of an isotope, and comparing the observed counting rates with their expected relative ratios, calculated from the decay constant of the isotope used. To limit the duration of such tests, a short-lived isotope must be used and since some or all of the counting periods will be comparable to the half-life of the isotope, the mean observed counting rates have to be converted to instantaneous rates. The use of ^{137m}Ba for tests of this nature is described. This isotope was chosen because it can be separated easily and efficiently from ^{137}Cs , and its half-life is accurately known as 153.08 ± 0.004 sec. A halogen-quenched G-M counter with a resolving time (τ) of 379 ± 1 msec was used. A solution containing ^{137m}Ba was placed adjacent to the G-M counter,

and the measurements commenced when the counting rate was 80,000 cpm. The results demonstrated that the true instantaneous counting rates at the various counting periods were linearly related to their corresponding theoretical ratios. It was therefore concluded that the value of τ was correct, and that the G-M counter performed correctly up to 80,000 cpm where 50% of the pulses were not recorded due to τ . A constant standard deviation could be obtained for all readings by simply increasing the counting periods during the decay of the source. This has the additional advantage of ensuring an even distribution of the experimental points with respect to the relative ratios of their counting rates. The use of short-lived isotopes as outlined here offers a rapid, critical, and valuable test for checking the performance of any nucleonic apparatus. It serves as an overall test since the detector is also used. Apart from checking whether τ has been correctly determined, direct information is obtained on the max counting rate that can be handled by such equipment. The conversion of mean to instantaneous rates can be carried out rapidly because tables containing correction factors are available. (BBB)

17687 RADIATION CHEMISTRY. Collinson, E. (Univ. of Leeds, Eng.). Ann. Rep. Progr. Chem. (Chem. Soc. London), 62: 79-105(1965).

Advances in radiochemistry of organic compounds since 1961 are reviewed with 217 references to the literature. In a discussion of gaseous organic systems, data are presented relating to the participation of ions, excited molecules, and free radicals in radio-induced decomposition of hydrocarbons. Properties of radicals are considered. Much work has been done on the properties of the hydrated electron, mostly on constants, by the pulse radiolysis technique, for reaction of e_{aq}^- with itself, with other radicals arising from water, and with added inorganic or organic solutes. Investigations of water in the solid state showed that the response of the solid, and the observation by ESR and optical spectroscopy of stabilized intermediates, may reflect equivalent occurrences in the liquid. The effects observed by ESR in acidic glasses containing a wide range of solutes were interpreted in terms of reactions of mobile electrons and positive holes, which may initially exist in irradiated pure ice in an exciton-like bound state. (TSS)

17730 CONTRIBUTION ON THE CHEMISTRY OF PROTACTINIUM. Dinstl, Georg (Univ., Vienna). Radiochim. Acta, 6: 125-7(Dec. 1966). (In German).

Methods for extracting protactinium with long-chain amines (LA-1, LA-2-Dodecylamin) are described. By adding carriers (^{231}Pa) easily reproducible extraction curves were obtained. An account is given on the use of molecular plating for the production of thin layers of protactinium suitable for the γ spectroscopy of this element. By use of dioxan as organic phase and voltages up to 10,000 V 90% of the protactinium could be deposited on small sheets of special steel. (auth)

19531 NUCLEAR RESEARCH AND TECHNIQUES IN THE GERMAN FEDERAL REPUBLIC. Rembsen, Josef (Ministere Federal de la Recherche Scientifique, Godesberg, Ger.). Bull. Inform. Ass. Belge Develop. Pac. Energ. At., 11: No. 64, 9-22; 27(Nov. 1966). (In French).

An outline is given of the nuclear research and development undertaken in the German Federal Republic by the state, universities and independent institutes, and industry. The contribution of the Republic to EURATOM and CERN is first outlined. Nuclear research in the German universities and Max Planck institutes, German nuclear research establishments, and industrial development of nuclear techniques are then summarized. (J.S.R.)

INTERNAL DISTRIBUTION

1-27. P. S. Baker	34-35. Central Research Library
28-29. Martha Gerrard	36. Laboratory Records - RC
30. J. H. Gillette	37-39. Laboratory Records
31. Robert H. Lafferty, Jr.	40. Document Reference Section
32. F. E. McKinney	41. ORNL Patent Office
33. A. F. Rupp	

EXTERNAL DISTRIBUTION

42. C. R. Ballarene, Librarian, Isotopes, Inc., 123 Woodland Ave., Westwood, N. J. 07675
- 43-44. Dr. Felipe de la Cruz Castillo, Jefe División de Química, Junta de Energia Nuclear, Direccion de Quimica e Isotopos, Av. Complutense Madrid 3, Spain
45. C. H. Collins, Western New York Nuclear Research Center, Inc., Power Drive, Buffalo, New York 14214
- 46-47. Mary McClure, DID, AEC, Wn.
48. M. V. Ramaniah, Radiochemistry Division, Bhabha Atomic Research Centre, South Site, Trombay, Bombay 74, India
49. G. J. Rotariu, DID, AEC, Wn.
- 50-65. DTIE
66. Research and Development Div., AEC - ORO