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

Martha Gerrard and P. S. Baker

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ISOTOPES INFORMATION CENTER

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

(From NSA July-December 1967)

Martha Gerrard and P. S. Baker

FEBRUARY 1968

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

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

(From NSA July-December 1967)

Martha Gerrard and P. S. Baker

ABSTRACT

More than 575 abstracts of non-U.S. publications on production and use of radioisotopes and radiation, selected from the July-December issues of Nuclear Science Abstracts (1967) 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, July-December issues.

GENERAL

26066 (NP-16474) RAPPORT D'ACTIVITES, 1965. (Report of Activities, 1965). (Commissariat à l'Energie Atomique, Tunis (Tunisia)). 80p. (In French). Dep. mn.

An outline is given of the activities of the Tunisian CEA during 1965. These include reactor project, prospecting, nuclear physics, use of radioisotopes, protection against and control of radiations, and solar energy. Relations with national, international, and foreign organizations are summarized. (J.S.R.)

22238 (NP-16547) ANNUAL REPORT, JANUARY 1, 1965-DECEMBER 31, 1965. (Middle Eastern Regional Radioisotope Centre for the Arab Countries, Cairo (Egypt)). Jan. 1966. 38p. Dep. mn.

Activities in the training of specialists in the application of radioisotopes in science, industry, agriculture, and medicine and in research using radioisotope techniques are reported. Hydrochemical investigations of underground water were carried out in the United Arab Republic, Libya, and the Sudan. Sodium-22 was used to determine the exchangeable Na and the soil cation exchange capacity in soils. Tracer techniques were also used to study nitrogen and phosphorus uptake by plants growing on various soils and in water-use efficiency studies. Progress on eradication of *Anopheles pharoensis* and *Ceratitis capitata* by radio-sterilization techniques is reported. Medical studies during the report period were concerned with ancylostomiasis, bilharziosis, and iodine metabolism in endemic goiter. A list of 29 references to papers published on work performed at the center is included. (H.G.D.)

39145 USE OF RADIOISOTOPE TECHNIQUES IN SWEDEN. Erwall, Lars G. (Isotope Techniques Lab., Stockholm). Isotop. Radiat. Technol., 4: 255-8(Spring 1967).

Radiotracer work in Sweden is carried out under both government and private-industry sponsorship. As examples of the fields of activity, the uses of radiotracers in industrial processes, furnace-lining wear, and water pollution, in identifying metal products, and in activation analysis are discussed. (auth)

39137 SOME RECENT WORK CARRIED OUT BY THE INDUSTRIAL ADVISORY DEPARTMENT OF THE AUSTRIAN REACTOR CENTRE, SEIBERSDORF. Cless-Bernert, T. (Abteilung Industrieberatung/Isotopenanwendung des Reaktor-zentrums, Seibersdorf, Austria). Isotopenpraxis, 3: 217-20 (June 1967). (In German).

For stimulating industrial applications of isotopes, the Industrial Advisory Department of the Austrian Reactor Center has executed investigations taking advantage of isotopic labelling and other methods for some years. Some examples of the activity of this institution are given: autoradiographic and radiometric determination of boron in borated steels, determination of the distribution of asbestos fibers in asbestos-cement plates and of bitumen spray under the concrete plates of highway lanes, construction of a movable beta irradiation chamber of 1 MRAD/h. (tr-auth)

39149 USE OF LARGE RADIOISOTOPE SOURCES IN CANADA, UNITED KINGDOM, AND JAPAN. Gerrard, Martha. (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 4: 295-301(Spring 1967).

Information on the use of large radioisotope sources in Canada, the United Kingdom, and Japan is presented. Work in Canada on radiopreservation of potatoes, radiosterilization of pharmaceuticals, chemical synthesis, and cobalt-60 teletherapy is summarized and the mobile ⁶⁰Co food irradiator described. The Wantage Laboratory package irradiation plant in England, sterilization of medical supplies, food processing, acceleration of chemical processes, ⁶⁰Co teletherapy, and research on heat sources for navigational lights are briefly described. Work in Japan has been concentrated on producing and improving the properties of high-molecular weight materials by means of radiation. (F.S.)

36280 INDUSTRIAL ISOTOPE TECHNOLOGY IN JAPAN. Erwall, L. G. (Isotopetkniska Laboratoriet, Stockholm). Tek. Vetensk. Forsk., 3: 72-4(1967). (In Swedish).

A survey is given of the various applications of radioisotopes in industry, tracer methods in metallurgy and iron production, activation analysis applied to the mapping of high mercury contents in fish and rice, and radiochemistry for research on radiation induced reactions and development of industrial processes. Information on capital investments and volume of activities is summarized. (SWED)

28177 RADIOIZOTOPY V STROITEL'STVE FUNDAMENTOV I PODZEMNYKH SOORUZHENII. (Radioisotopes in Foundation Constructions and Underground Installations). Smorodnov, M. I. Moscow, Atomizdat, 1967. 156p.

The use of radioactive isotopes in foundation construction and underground installations is examined. Examples of the use of radioisotopes for increasing the productivity of plants and automation of industrial processes are reported. Apparatus and equipment used for obtaining raw data during the design of underground installations are described. The radioactive tracer method used to study stressed masses in a nondestructive manner and to make a selection of the optimum parameters of instruments and work regimes for underground cycle machines is also described. (tr-auth)

39029 (AFRE-R-5368) A SURVEY OF THE APPLICATION OF RADIATION TECHNIQUES IN OIL AND MINERAL BORE-HOLES. Clayton, C. G. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Feb. 1967. Revised July 1967. 74p. Dep. CFSTI, UK 10s.

The application of radiotracers and radioisotope instruments in the exploration and exploitation of oil and gas reserves and in mineral prospecting was surveyed. In the oil industry, the most important techniques include natural- γ logging to identify underground lithology, and (γ, γ), (n, n) and (n, γ) logging to determine mineral density and porosity and water and oil saturation levels. The neutron die-away method is now in wide use to locate and follow oil/water interfaces. Nuclear geophysical methods, especially selective (γ, γ) logging, neutron activation logging and x-ray fluorescence techniques are currently being used and developed for mineral prospecting. This survey emphasizes the limitations of the techniques, and comments on current theoretical treatments have been included. (auth)

36143 GEOFIZICHESKAYA APPARATURA. VYPUSK 29. (Geophysical Apparatuses. Volume 29). Vikulin, B. K. (ed.). Leningrad, Izdatel'stvo Nedra, 1966. 215p.

Design and performance of magnetic seismographic, radiometric, and computing devices used in geophysical prospecting are described. Nuclear magnetometers, x-radiometers, neutron activation and photonuclear analyzers are discussed. The performance of high voltage sinusoidal transformers for field neutron generators, radiofrequency cables, and transistorized x-ray spectral tubes and computers are also discussed. (R.V.J.)

39152 ISOTOPENTECHNIK UND TEXTILINDUSTRIE. LITERATURNACHWEIS. (Isotope Technology and Textile Industry. Literature Review). van Wauwe, O.; Brandenburg, D. Informationsheft des Buero Eurisotop, 6. Serie: Bibliographien-2. Brussels, EURATOM, 1965. 206p. 10 D. M.

One hundred and eight references on radioisotopes in the textile industry are presented and then arranged according to the following subjects: review articles, use of radioactive tracers, activation analysis, irradiation, radiation-chemical processes, measurement methods by radiation absorption, and reduction of static electricity. Subject and author indexes are included along with a list of organizations, institutes, and industries. (M.C.G.)

26012 NATIONAL CONFERENCE ON THE TECHNOLOGY OF THE SEA AND SEA BED. Atom, No. 127, 111-22(May 1967).

The papers presented at the Conference held at the Atomic Energy Research Establishment, Harwell, England, on April 5 to 7, 1967 are reviewed. These include the following: the use of nuclear explosives for sea-bed mining; extraction of uranium and other inorganic materials from sea water; unconventional nuclear power sources; the use of fuel cells on and under the sea; nuclear reactors for underwater power; application of radioisotope tracers to spoil ground selection; and Harwell oil pollution work. (UK)

36126 ISOTOPE TECHNIQUES IN THE HYDROLOGIC CYCLE. Papers Presented at a Symposium at the University of Illinois, November 10-12, 1965. Stout, Glenn E. (ed.). Geophysical Monograph Series, Number 11. Washington, D. C., American Geophysical Union, 1967. 205p. (CONF-651108).

A total of 28 papers were presented at the Symposium. Six of the papers were previously abstracted in NSA. Separate abstracts were prepared for the remaining 22 papers. (J.R.D.)

For abstracts of individual papers see: 36127-36142 and 36153-36158.

36022 TABLES OF NUCLEAR CHEMISTRY. Zeman, A. Chem. Listy, 60: 683-4(May 1966). (In Czech).

A table of isotopes with data on half-life, radiation energy, and other chemical and radiochemical properties is presented. Safety measures are described. Chemical properties of radioactive materials, ion exchanges, extraction by organic solvents in nuclear chemistry, products of radioactive decay, chemical and physical properties of products of decay, and some metals currently used in nuclear technology are discussed. The available literature and the best way of using published information are considered. (JPRS)

28175 THE TECHNICAL APPLICATIONS OF RADIOACTIVITY. VOLUME I. Broda, E.; Schoenfeld, T. Oxford, Pergamon Press, 1966. 353p. 105s.

The fundamentals and measurement of radioactivity are discussed, together with the production and chemistry of radioelements, and the use of radioactive tracer methods. Applications include chemical analysis, mining and oil production, metallurgical, engineering and electrical industries, general problems of the chemical industry, agriculture and forestry, and hydrology and water supply. A section is included on radiation protection. (UK)

23844 NUCLEAR TECHNIQUES IN FORENSIC SCIENCE. Coleman, R. F. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Brit. Nucl. Energy Soc., 6: 134-8(Apr. 1967).

The value of nuclear methods in forensic science is discussed and illustrated with many examples. The techniques provided information in toxicological studies of heavy metals, particularly arsenic. The detection of gun residues assists in interpretation of cases involving firearms in several ways. The value of the techniques in establishing a common origin in samples is indicated, and specifically applied to providing a quantitative assessment of hair comparison by trace element analysis. (UK)

28079 (PEL-144) APPLICATION OF RADIOISOTOPES AND RADIATION IN HYDROLOGY. A Bibliography. Rossouw, S. F. (comp.) (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Feb. 1967. 17p. Dep.

Twenty four references with abstracts are included. These references update a previous bibliography (PEL-85) on the same subject. (D.E.B.)

36024 PREPARATION AND APPLICATIONS OF RADIOACTIVE PHOSPHORUS ISOTOPES. Vasaros, Laszlo; Berei, Klara; Kiss, Istvan (Central Research Inst. for Chemistry, Budapest). Magy. Tud. Akad. Kem. Tud. Oszt., Kozlem., 26: 261-95(Nov. 1966). (In Hungarian).

Literature dealing with the preparation of ^{32}P preparates, preparation of ^{32}P , hot-atomic chemical reactions of ^{32}P , preparation of compounds labeled with ^{32}P , assaying and analysis of radioactive phosphorus preparates, and the applications of ^{32}P (medical, agricultural, industrial, physical, and chemical) was reviewed in considerable detail. (362 references). (JPRS)

41151 (PRNC-82) ANNUAL REPORT, 1965. (Puerto Rico Nuclear Center, [Mayaguez]). Contract AT(40-1)-1833. 225p. Dep. CFSTI.

Program accomplishments and activities in nuclear science and engineering and in the applications of nuclear energy in medicine, agriculture, and industry are reviewed. Educational and training programs, biological and medical research, physical research, and radiation preservation of tropical foodstuffs are discussed. (M.C.G.)

45447 III KRAJOWE SYMPOZJUM ZASTOSOWAN IZO-TOPOW W TECHNICIE, SZCZECIN, 31 V-3 VI 1966. (Third National Symposium on Application of Isotopes in Technology, Stettin, Poland, May 31-June 3, 1966). [Warsaw, Palac Kultury i Nauki, 1966]. 850p. (CONF-660571 (Pt.1)).

The conference included 159 papers on the applications of radioisotopes. These applications include radiometric instruments, tracer techniques, radiometric methods of analysis, neutron sources and other radiation sources, etc. Papers 1 through 85, inclusive, are contained in part I. (C.E.S.)

23828 ANALYSIS OF PURE MATERIALS: SOME GENERAL COMMENTS. Smales, A. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Mater. Sci., 1: 302-7(Aug. 1966).

The use of absorption, fluorescence, emission, fluorescent x-ray, and mass spectroscopy; nuclear magnetic resonance; radioactive tracers; neutron activation; and other methods for analysis of pure materials, particularly those used in nuclear research, is reviewed. Some desirable characteristics of analytical techniques are listed. Fluorescence spectroscopy, an individual element method, offers a potential improvement in sensitivity over straight absorption spectroscopy, $\sim 10^{-7}$ g is a likely level. The use of the yellow fluorescence of hexavalent U in a solid phosphor of sodium fluoride is cited as an example of a highly sensitive, highly specific method of determining as little as 10^{-8} g. Emission spectroscopy is important in nuclear energy work. Its advantages are that several elements may be determined simultaneously, in some cases directly on the sample material. X-ray fluorescence spectroscopy has the advantages in the ability to carry out nondestructive analysis on small samples for several elements; for some materials, such as Be, at the level of 10 to 100 ppm. In combination with mass spectrometry, isotope dilution proved to be a sensitive method (another is radioactivation); sensitivity down to 10^{-12} g or less is possible, and sensitivity down to 10^{-9} g was obtained at Harwell for many elements. Radioactivation is one of the most sensitive methods available and has the additional advantage of being free from the reagent blank problem. Sensitivity varies for each element, but with a neutron flux of 10^{12} n/cm² sec a wide range of elements can be determined at levels between a microgram and a picogram. Irradiation of a sample followed by autoradiography may be of help in location of impurities in suitable materials. (BBB)

30643 RADIOISOTOPES IN INDUSTRY. NOTES ON CONFERENCE AT UNIVERSITY OF SOUTHAMPTON, ENGLAND, 21ST APRIL 1966. Southampton, Eng., Univ. of Southampton. 19p.

Notes are included on the following discussion topics: How radioisotopes work—Radioisotope instruments for measurement, control and analysis—Non destructive testing by gamma radiography—Radioisotopes as tracers for mixing and flow studies, for "trouble shooting", and in analysis—Radiological safety and legal requirements—Isotope powered thermoelectric generators—Advice and services available to industry. (UK)

36086 PROBLEMS OF UTILIZING RADIOACTIVE PROCESS WASTE. Ullmann, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 10: 1-8(Jan. 1967). (In German).

The problems of utilizing radioactive process waste are reviewed. The character and amount of radioactive process waste produced per year are summarized. The methods used for separation of fission products and applications of various fission products are described. Possible future uses of waste products are indicated. (66 references.) (J.S.R.)

41292 (NP-16972) ANNUAL REPORT OF THE DEPARTMENT OF ATOMIC ENERGY, GOVERNMENT OF INDIA, 1966-67. (Department of Atomic Energy, Bombay (India)). 74p. Dep.

The reactors Apsara, Circus, and Zerlina were fully utilized for research and isotope production at the Bhabha Atomic Research Center (BARC). Other activities at BARC include preparation of Pu-Be neutron sources, development of plasma guns, basic physics research, development of nuclear instruments and radiation detectors, production of U, production of heavy water, fuel processing, waste management, research on actinide elements, and medical and biological research. Activities at the Tata Institute include mathematics research, research on particle physics, computer development, studies of angular correlations of radioactive nuclei, NMR studies of liquid metals, semiconductors, and rare earths, investigations of cosmic radiation, geophysics research, radioastronomy investigations and research on molecular biology. Activities at other research institutions are briefly summarized. (J.R.D.)

45155 PRODUCTION AND USE OF RADIOISOTOPES IN FRANCE. Fisher, C. (CEA, Saclay, France). *Isotop. Radiat. Technol.*, 4: 189-94 (Winter 1966-1967).

The production and use of radioisotopes in France are managed chiefly by the Commissariat à l'Energie Atomique (CEA), which manufactures practically all radioisotopes, radiochemicals, and radioactive sources. It also is concerned with research and development on industrial uses of radioisotopes and radiation and helps industry utilize these techniques. The program was integrated with production centers in Belgium and Italy since the early 1960's. The Belgium program is oriented toward production of high-specific-activity radioisotopes in the BR-2 reactor while the Italian program is limited mainly to radiopharmaceuticals. The French program includes production of irradiated materials, processed isotopes, radiopharmaceuticals, labeled organic compounds, and sealed sources for industry. (M.M.B.)

45181 CATALOGUE OF RADIOACTIVE PRODUCTS 1967/68. Amersham, Eng., United Kingdom Atomic Energy Authority, 1967. 215p.

Details are given on the ordering, distribution, packaging, delivery, insurance, prices and payment, and licensing and registration procedures for radioactive products. The catalog covers radioisotopes and labeled compounds, medical products, radiation sources, material for instrument calibration, and general services. (UK)

45318 ABSTRACTS OF THE 3RD ANNUAL MEETING ON RADIOISOTOPES IN THE PHYSICAL SCIENCES AND INDUSTRY [TOKYO UNIVERSITY, APRIL 19-21, 1966]. (Tokyo, Tokyo Univ., 1966). 166p. (In Japanese and English). (CONF-660454).

One hundred and ten abstracts of papers given at the 3rd Annual Meeting on Radioisotopes in the Physical Sciences and Industry, held in Tokyo in April 1966, are presented. (L.C.L.)

45306 (CEA-Bib-94) LISTE NON EXHAUSTIVE DE REFERENCES A DES TRAVAUX FRANCAIS PUBLIES EN 1965 ET 1966 DANS LE DOMAINE DES APPLICATIONS INDUSTRIELLES DES RADIOELEMENTS. (Nonexhaustive List of References to French Work in the Field of the Industrial Applications of Radioelements in 1965 and 1966). (Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1967. 22p. (In French). Dep.

A bibliography of 186 references, which is incomplete and covers only two years, gives an idea of the importance of French work in the field of the industrial applications of radio isotopes. Included are references on analysis, hydrology and sedimentology, but not biological and medical applications. The C.E.A. contributed 100 references; of this number, 29 correspond to C.E.A. notes (CEA-N) which are not prepared with a view to being widely distributed but have been judged to be of interest and to represent an important part of the work of the Radioisotope Application Section. (tr-auth)

41150 (NP-16994) APPLICATION OF LARGE RADIATION SOURCES IN ISRAEL. Foa, E.; Lapidot, M. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). [1965]. 118p. Dep.

Progress in the use of large radiation sources in Israel during 1964 to 65 is reported. Programs for the use of large sources in agriculture and industry for 1965 to 66 and a forecast for their use in 1966 to 71 are described. Technological and economic surveys were made of the use of large radiation sources for the radio-preservation of agricultural produce, fish, and meat and for industrial applications related to chemistry, plastics, wood, plywood, building materials, and hospital supplies. (F.S.)

ISOTOPE AND LABELED-MATERIAL PRODUCTION

28013 RADIOISOTOPE PRODUCTION AND PROCESSING. Rahman, Muttur (Atomic Energy Centre, Dacca, Pakistan). *Nucleus (Lahore)*, 3: 66-8 (July-Sept. 1966).

Development of an isotope production program for Pakistan using an available 5 MW research reactor is announced. Standards for control and administration of the program are discussed. (P.C.S.)

27991 (AAEC/TM-360) A FIVE YEAR PROGRAMME FOR RADIOISOTOPE PRODUCTION AT THE RESEARCH ESTABLISHMENT. Boyd, R. E.; Engelbert, U.; Gregory, J. N.; Miles, G. L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov. 1966. 24p. Dep.

Plans for radioisotope production at Lucas Heights over the period 1966-71 are summarized, and indications are given as to how these are based on present trends of demand for radioisotopes. The program is discussed in terms of available staff and facilities; while some small staff increases will be required, the facilities presently being commissioned should be adequate over this period. (auth)

25378 PREPARATION OF THIN OSMIUM TARGETS. Avida, R.; Mustachi, A. (Hebrew Univ., Jerusalem). *Nucl. Instrum. Methods*, 50: 351-2 (1967).

A safe and reliable method is described for the preparation of osmium targets by electrodepositing a colloidal suspension of osmium dioxide in ethanol. (auth)

41430 RADIOAKTIVNYI KOBAL'T ^{60}Co . (Radioactive ^{60}Co). Sinitsyn, V. I. Moscow, Atomizdat, 1967. 112p.

A brief review (35 bibliographies) on the preparation of ^{60}Co is presented. Safety measures that should be followed by personnel during handling, storage, and transportation of ^{60}Co are discussed. Descriptions of large industrial γ -radiation facilities are also included. (R.V.J.)

32197 PREPARATION OF ^{85}Br COMPOUNDS AND CARRIER-FREE ^{85}mKr . Sonnino, T.; Pasternak, M. (Soreq Nuclear Research Center, Israel). *Int. J. Appl. Radiat. Isotop.*, 18: 535-7 (July 1967).

The preparation of ^{85}mKr by neutron irradiation of ^{82}Se in natural selenium, which contains 9% of the isotope-82, is described. The ^{82}Se formed decays to 2.4-hr ^{85}Br which in turn decays to ^{85}Kr . Chemical procedures and results are presented. (J.G.B.)

40401 THE PRODUCTION OF RADIOISOTOPE ^{28}Mg . Mori, M.; Chiba, R.; Tani, A.; Aikawa, H.; Kawai, N. (Nippon Atomic Industry Group Co. Ltd., Kawasaki, Japan). *Int. J. Appl. Radiat. Isotop.*, 18: 579-83 (Aug. 1967).

Magnesium-28, with a 21-hr half-life, was produced in a specific activity of 100 mc/g by a $^{28}\text{Mg}(t,p)^{28}\text{Mg}$ reaction, using tritono accelerated by an electrostatic accelerator. Magnesium oxide enriched to 99.6% in magnesium-26 was used as a target. About 250 μ curies of magnesium-28 were obtained in 2 hr irradiation. The total cross section of the $^{28}\text{Mg}(t,p)^{28}\text{Mg}$ reaction was measured as a function of the triton energy up to 3.5 MeV. (auth) (UK)

36014 THE PRODUCTION OF CARRIER-FREE ^7Be IN NUCLEAR REACTORS BY THE SECONDARY NUCLEAR REACTION $^7\text{Li}(p,n)^7\text{Be}$. Aumann, D. C. (Technische Hochschule, Munich). *Radiochim. Acta*, 7: 64-71 (June 1967). (In German).

Carrier-free ^7Be was produced by irradiating hydrogen-containing lithium compounds in the Munich Research Reactor by the secondary nuclear reaction $^7\text{Li}(p,n)^7\text{Be}$ using protons from neutron-hydrogen atom collisions. The dependence of the ^7Be production yield on the chemical composition of the irradiated compounds was investigated and compared with the predicted production yields. Radiochemical methods for the isolation and purification of the carrier-free radioberyllium from the irradiated lithium compounds was investigated. A simple separation scheme is proposed. (auth)

44616 YIELDS OF RADIOACTIVE ISOTOPES ^{22}Na , ^{54}Mn , ^{51}Co , AND ^{181}W IN NUCLEAR REACTIONS WITH PROTONS, DEUTERONS, AND ALPHA PARTICLES. Dmitriev, P. P.; Krasnov, N. N. (Physico-Energetic Inst., Obninsk, USSR). *Chem. Zvesti*, 21: 611-15 (1967). (In Russian).

Different methods for preparation of radioactive isotopes ^{22}Na , ^{54}Mn , ^{51}Co , and ^{181}W in cyclotrons are discussed. Yields of these isotopes obtained in different nuclear reactions are given, and for each of them an optimal method of preparation is recommended. On the basis of the yields of ^{22}Na , ^{54}Mn , ^{51}Co , and ^{181}W attained in the nuclear reactions with protons, deuterons, and alpha particles, it can be concluded that for the nuclear reaction in which most favorable yields are attained, three kinds of accelerated particles are necessary: protons ($E_p \sim 20$ MeV), deuterons ($E_d \sim 20$ MeV), and alpha particles ($E_\alpha \sim 40$ MeV). (auth)

30486 INVESTIGATIONS ON THE SZILARD-CHALMERS EFFECT AT REACTOR CONDITIONS. Toerkoe, Janos. *Energ. Atomtech.*, 20: 200-3 (Apr. 1967). (In Hungarian).

After a theoretical discussion of the Szilard-Chalmers effect the possibility of making use of this phenomenon in the production of radioisotopes is considered. Using various compounds of chromium as target, dependence of yield and specific activity of the ^{51}Cr formed on the time of activation and temperature of target was examined. Taking into consideration the conditions in the reactor (neutron flux, gamma radiation and temperature in the irradiating channel, etc.) a method was worked out for production of ^{51}Cr in a quality required for diagnostic use. (auth)

27527 PRODUCTION OF ^{18}F BY SMALL RESEARCH REACTOR. Maruyama, Yoshiaki (Musashi Inst. of Tech., Tokyo). *J. Nucl. Sci. Technol. (Tokyo)*, 4: 185-9 (Apr. 1967).

High-purity ^{18}F was prepared by irradiating 1 g of lithium hydroxide or otherwise 0.14 g of enriched lithium carbonate containing 50% ^6Li in the pneumatic tube of a TRIGA-II research reactor at a thermal neutron flux of 1.2×10^{12} n/cm 2 ·sec. After cooling for 20 min, the irradiated lithium hydroxide was dissolved in distilled water. The resulting ^{18}F was separated from the irradiated target by passing the lithium hydroxide solution successively through ion exchange columns of H-, OH-, and H-forms. Use was also made of the Co-form ion exchange column in place of the H-form for the elimination of impurities. In the case of ^6Li enriched lithium carbonate, the irradiated lithium carbonate was dissolved in hydrochloric acid, and ion exchange columns of Ag-, OH-, and H-forms were used for purifying the ^{18}F . The product ^{18}F was obtained in the form of water containing ^{18}F . The chemical yield for the purification of ^{18}F was about 80%, and the final radioactive impurities were less than 1 ppm. A neutron activation method for determining the isotopic abundance of ^6Li was developed using the nuclear reactions $^6\text{Li}(n, \alpha)^3\text{H}$ and $^{10}\text{O}(t, n)^{18}\text{F}$. Aqueous solutions containing lithium were irradiated in pneumatic tube for 1 hr. ^{18}F was separated by steam distillation from the irradiated solutions and precipitated as magnesium fluoride. The chemical yield for the separation of ^{18}F was about 80%. The sensitivity limit was estimated to be 4 μg of natural lithium. (auth)

25911 THE PRODUCTION OF ^{39}Ar USING REACTOR NEUTRONS. Schmeling, Per (Kernforschungszentrum, Karlsruhe, Ger.). *Radiochim. Acta*, 7: 58 (Mar. 1967).

The use of the $^{39}\text{K}(n, p)^{39}\text{Ar}$ reaction to produce ^{39}Ar of high specific activity was investigated. Potassium chloride can be used for the production of ^{39}Ar , but high doses produce ^{35}S and small amounts of ^{36}Cl . The production of ^{36}Cl and other contaminants by (n, γ) reaction can be avoided by irradiation in cadmium. Potassium chloride was irradiated in the thermal column of FR2 reactor to an integrated flux of 3.7×10^{17} cm $^{-2}$; but no ^{39}Ar could be found. It was estimated that the cross section for thermal neutrons was less than 0.05 mb. The effective cross sections for the reaction $^{39}\text{K}(n, p)^{39}\text{Ar}$ for the FR2, BER, and BR2 reactors are given. (D.H.M.)

Separation

36060 (NP-tr-1564) PREPARATION OF CARRIER-FREE ^{35}S . Cifka, J.; Vins, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Translated by L. H. Sinclair for Atomic Energy Research Establishment, Harwell, Eng., from report UJV-1510. 35p. Dep. CFSTI. JCL \$3.60 fs, \$1.28 mf.

Literature on the methods of preparation of carrier-free ^{35}S is reviewed, and the results of laboratory tests on some of these methods are described. The Yugoslav method of sorption of ^{35}S on aluminum oxide has been chosen for routine production. The production apparatus and operational experience since 1960 are described. Separate sections are devoted to the measurement and decontamination of the ^{35}S activity. (56 references). (auth)

36088 RADIOCHEMICAL ISOLATION. IV. SEPARATION OF THE TARGET MATERIAL FROM THE PRODUCTS OF CEURIUM FISSION. Mastalka, A.; Chalkin, V. A.; Lebedev, N. A. (Inst. of Nuclear Research, Prague. Joint Inst. for Nuclear Research, Dubna, USSR). *Collect. Czech. Chem. Commun.*, 32: 1604-8 (Apr. 1967). (In German).

The separation of macromasses of Ce from mixtures of its fission products by distribution chromatography using a stationary organic phase was investigated. Nitromethane, dibutyl phosphate, bis(2-ethylhexyl) orthophosphate, and tributyl phosphate were the organic phases investigated. Study showed that low nitric acid concentrations favor the separation of the Ce. Tributyl phosphate and the bis(2-ethylhexyl) orthophosphate both gave satisfactory results in the separation. With dilute nitric acid the Ce together with Pr was eluted from the column at the very beginning of the elution. Cs, Ba, and La were eluted with 14M HNO_3 . (J.S.R.)

21988 PREPARATION AND APPLICATION OF THE RADIO-NUCLIDE ^{130}I . Duftschmid, K. E.; Sorantin, H. (Oesterreichische Gesellschaft fuer Atomenergie GmbH, Selbersdorf, Austria). *Monatsh. Chem.*, 97: 1332-8 (1966). (In German).

Determination of ^{130}I by γ spectrometry is best achieved by integral measurement with a discriminator wave at 0.2 MeV. Separation from ^{131}I is achieved by use of a discriminator wave of 0.8 MeV for measurement of the ^{130}I line at 1.15 MeV. The preparative procedure uses a sample from natural U irradiated 3900 Mw-days and stored 1½ years. The sample is dissolved in HNO_3 and the ^{127}I and ^{129}I absorbed in alkaline bisulfite solution. This was acidified and the SO_2 driven off. Iodide was then oxidized to I_2 with H_2O_2 and extracted with CCl_4 ; the organic phase was treated with SO_2 and the iodide extracted with water. This cycle was repeated 3 times. The final aqueous solution was boiled to remove SO_2 and the solution made weakly ammoniacal and evaporated; the residue was dissolved in 0.1N NH_3 and evaporated in a quartz capsule, which was placed in the reactor. After decay of ^{129}I , the spectrum of ^{130}I was obtained contaminated with ^{64}Cu . The latter was removed by two cycles of the type given earlier. A small amount of activity (1%) is due to ^{129}I . Irradiation for 25 hours with 10^{14} n/cm 2 ·sec produces 8 mCi ^{130}I /mg (^{127}I + ^{129}I) of 99% purity. (BBB)

35985 (CEA-R-3153) PRODUCTION DE L'IODE 131 PAR VOIE SECHE A PARTIR DE TELLURE ELEMENTAIRE IRRADIE A LA PILE. 1 ERE PARTIE. ETUDES DES CONDITIONS POUR OBTENIR L'EMANATION DE L'IODE ET LE CAPTER. (Iodine-131 Production by a Dry Method Using Reactor-Irradiated Elementary Tellurium. Part I. Conditions for Obtaining Iodine Emanation and its Capture). Bardy, Andre; Beydon, Jacqueline (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1967. 16p. (In French). Dep.

A dry method was developed for separating ^{131}I obtained by reactor-irradiation of elementary tellurium. It involves heating the irradiated tellurium to about 400°C. It is relatively simple to treat 400 g of tellurium and to collect 90% of the ^{131}I thus formed. (auth)

45169 SEPARATION OF RECOILING CHROMIUM(II) SPECIES FROM NEUTRON-IRRADIATED HEXAQUOCHROMIUM(III) ION ADSORBED ON ION-EXCHANGER. Matsuura, Tatsuo; Sasaki, Takashi (Rikkyo Univ., Yokosuka, Japan). *Radiochim. Acta*, 8: 33-7 (Sept. 1967).

Continuous extraction of the ^{51}Cr -enriched chromous species during neutron-irradiation of hexaquo chromium ion adsorbed on a cation-exchange resin was carried out with oxalic acid and other eluents, and this dynamic method gave higher yields and enrichment factors than the static irradiation method. Dynamic irradiations at controlled temperatures were also performed for the first time and the effects of irradiation temperature and of bead radius on the separable yield and the enrichment factor were studied. As expected, the enrichment factor increased with decreasing irradiation temperature. The inherent yield, which was estimated from extrapolation to zero bead radius, increased with increasing irradiation temperature, and this result could be interpreted on the hypothesis that thermodynamical equilibrium is established at the end of hot reaction in the recoil process. (auth)

43039 SEPARATION OF CARRIER-FREE ^{32}P FROM ELEMENTARY SULFUR ON AN ACTIVE CARBON COLUMN. Bebesel, P. I.; Turcanu, C. N. (Inst. of Atomic Physics, Bucharest). *Radiochim. Acta*, 7: 210-12 (Aug. 1967).

The separation of carrier-free ^{32}P from elementary sulfur on active carbon has been investigated. The radiophosphorus is adsorbed almost completely (99.5%) and the adsorption is not dependent on the quantity of the sulfur dissolved, which varied from 15 up 100 mg/ml. The most suitable eluent for the desorption of ^{32}P was found to be nitric acid. The efficiency of the desorption and its dependence on the concentration of nitric acid has been studied. The results indicate the possibility of a new method for the preparation of carrier-free phosphorus-32. (auth)

39023 METHOD OF PHOSPHORUS EXTRACTION. (to CEA). French Patent 1,406,025. June 8, 1965. Filed June 4, 1965.

Phosphorus-32 is extracted from neutron-irradiated S by contacting the molten S with a selective absorbent, e.g., Pyrex glass, SiO_2 , Al_2O_3 or stainless steel; separating said adsorbent, and eluting the adsorbed P with HCl + H_2O_2 or NaOH . (NPO)

24103 PROCESS FOR THE ISOLATION OF ^{32}P FROM IRRADIATED SULFUR. Radicells, Renato; Goso, Rogelio Pedro (to Comision Nacional de Energia Atomica). British Patent 1,066,066. Apr. 19, 1967. Filed Oct. 8, 1964.

A method for the isolation of ^{32}P from neutron-irradiated S comprises contacting a solution of the irradiated S with a material comprised of quartz or a Si-containing glass or ceramic and then recovering the ^{32}P retained by the material. Preferably, the retention material is in the form of particles having a diameter of from 0.3 to 1.0 mm. (B.L.M.)

45164 REACTOR PRODUCTION OF CARRIER-FREE ^{54}Mn FROM NATURAL IRON OXIDE. Barrachina, M.; Villar, M. A. (Junta de Energía Nuclear, Madrid). *Radiochim. Acta*, 8: 23-7 (Sept. 1967).

A radiochemical procedure was worked out to prepare carrier-free ^{54}Mn from neutron-irradiated ferric oxide of natural isotopic abundance. The procedure was designed to process large-size targets, 120 g, of especially purified ferric oxide. Target-iron was separated to better than 99.8% by a single batch extraction of its tetrachloroferric acid into diisopropyl ether. Residual iron was removed by a hydrochloric acid-anion exchange chromatographic step. The ^{54}Mn recovery yield of this procedure was over 98%. The main characteristics of the ^{54}Mn solution obtained are: specific activity ≈ 300 Ci/g Mn; radioactivity density ≈ 5 mCi/g solution; total iron decontamination factor $> 5 \cdot 10^6$; and ^{51}Cr decontamination factor $\approx 10^4$. (auth)

43028 SEPARATION OF RARE EARTHS ORIGINATING FROM URANIUM FISSION BY ELECTROPHORETIC ION FOCUSING. Guenther, E. W.; Starke, K. (Univ., Marburg, Ger.). *Chem. Zvesti*, 21: 561-70 (1967). (In German).

Electrophoretic ion focusing was investigated for its suitability in separation of short-lived rare earths. A rare earth mixture was fractionated from fission products in 5 min by solvent extraction, precipitation, ruthenium distillation, and anion exchange. The La, Ce, Pr, and Y fractions were identified by γ spectra and half-life and found to be radiochemically pure. (tr-auth)

32258 THE ISOLATION OF ^{105}Rh FROM NEUTRON IRRADIATED RUTHENIUM. Kobayashi, Y. (Japan Atomic Energy Research Inst., Tokyo). *J. Inorg. Nucl. Chem.*, 29: 1374-6 (May 1967).

Purified Ru metals were irradiated for 20 min with a neutron flux of 1×10^{13} n/cm² per sec. It was dissolved in a sodium hypochlorite solution and the ruthenium tetroxide produced was completely removed from the aqueous solution by extraction using carbon tetrachloride. To isolate ^{105}Rh from the aqueous solution, ferric ions were used as a carrier; $\text{Fe}(\text{OH})_3$ was precipitated. The $\text{Fe}(\text{OH})_3$ was dissolved in 9M HCl and FeCl_3 extracted into isopropyl ether, while the ^{105}Rh was left in the aqueous solution almost carrier-free. (M.C.G.)

42973 SEPARATION OF SOME RADIOACTIVE ISOTOPES FROM THE CYCLOTRON TARGETS. Sevast'yanov, Yu. G.; Bezmaternykh, A. S. (Physico-Energetic Inst., Obninsk, USSR). *Chem. Zvesti*, 21: 616-19 (1967). (In Russian).

Methods for separation of carrier-free radioactive preparations from the bulk of the cyclotron target material are reported. Methods for isolation of carrier-free ^{22}Na , ^{26}Al , and ^{74}As were developed. ^{22}Na was obtained in such a way that the magnesium target (alloy MA8) was irradiated with deuterons. Magnesium was activated and then precipitated to form magnesium sulfate; afterwards it was removed from the water-acetone solution. ^{22}Na was then retained on a cation exchanger from which it was desorbed with 0.1N HCl. ^{26}Al , which was formed in the course of the activation, was separated in the following way: it was precipitated as aluminum hydroxide with ammonia, this was transformed to soluble aluminate by means of NaOH, this was purified on anion, then it was sorbed on catex and desorbed with 2N HCl. Radioisotopes ^{74}As were prepared by irradiating germanium (Cu-Ge alloy) with deuterons and by their coprecipitation with iron hydroxide at pH 3.5 to 4.0. Separation from the iron and purification from germanium and ^{65}Zn was made by means of anion exchangers. These methods are suitable for separation of radioisotopes from industrial targets up to 100 g. (auth)

22020 PREPARATION OF CARRIER-FREE SILVER FROM PROTON-IRRADIATED PALLADIUM. Shiohawa, Takao; Yagi, Masuo; Suzuki, Teikichi; Hishinuma, Noboru (Tohoku Univ., Sendai). *J. Nucl. Sci. Technol. (Tokyo)*, 3: 549-50 (Dec. 1966).

A procedure was developed for separating the isotopes ^{105}Ag and ^{106m}Ag from Pd targets irradiated with 10-MeV protons. The procedure comprises dissolving the Pd metal target, separating the Pd on an anion resin, and depositing the Ag isotopes electrolytically for use as radiation sources. (D.L.C.)

21975 METHODS FOR PRODUCTION OF CARRIER-FREE ^{52}Mn AND ^{54}Mn . Kukula, F.; Mudrova, B.; Krivanek, M. *Isotopenpraxis*, 3: 49-51 (Feb. 1967). (In Russian).

Methods of ^{52}Mn and ^{54}Mn production are described. These methods are based on formation of water-insoluble manganese-thenoyltrifluoroacetone chelate, which may be selectively extracted from the reaction media by means of ethylacetate. The simple and fast operation together with minimal losses of product appear to be the main advantages of the described separation processes. The yield of ^{52}Mn and ^{54}Mn was found to be higher than 90% per single extraction with TTA. (auth)

40955 (EUR-3608.f) ELAN O: EXTRACTION DU CAESIUM DES PRODUITS DE FISSION SUR COLONNE D'ECHANGEUR MIXTE: PILOTE INACTIF. (ELAN O: Extraction of Cesium From Fission Products on Mixed Exchanger Column: Inactive Pilot Plant). Courouble, J. M.; Pesneau, A.; Prevotel, M. (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucleaires). July 6, 1967. 92p. (In French). Dep.

Laboratory results obtained with the phosphotungstate mixed exchanger led to consideration being given to the construction of a pilot plant capable of extracting cesium from actual fission-product solutions. The scale of 1000 Ci of cesium-137 extracted per operation was chosen in order to be compatible with the general shielding and effluent-discharge facilities available at the Saclay Center. Before constructing this pilot, however, it was necessary to carry out various operations on an apparatus of the same size but operating in an inactive medium. (auth)

43029 SEPARATION OF ^{106}Ru FROM FISSION PRODUCTS ON INORGANIC REDOX ION EXCHANGERS. Winkler, R.; Sansoni, B.; Starke, K. (Univ., Marburg, Ger.). *Chem. Zvesti*, 21: 571-8 (1967). (In German).

^{106}Ru was separated from a two-year-old fission-product mixture on an inorganic redox ion exchanger. The ^{137}Cs , ^{90}Sr , and rare earth (^{90}Y , ^{144}Ce , ^{144}Pr , and ^{147}Pm) nuclides bound at the same time on the ion exchanger could be selectively eluted. The ruthenium was separated by oxidative elution in about a 70% yield. The rest of the ruthenium and cerium, ^{90}Zr , and ^{95}Nb remained on the column under the conditions considered. (tr-auth)

45212 (RISO-159) NEW METHODS FOR THE CARRIERFREE PRODUCTION OF VARIOUS ISOTOPES BY THE LIQUID LIQUID EXTRACTION TECHNIQUE. Mirza, M. Younas (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug. 1967. 41p. Dep.

The extraction of Fe^{+3} , Cr^{+3} , Ni^{+2} , Co^{+2} , Mn^{+2} , Zn^{+2} , Sc^{+3} , Y^{+3} , La⁺³, alkali metals, alkaline earth metals, rare earth elements, and fission products at various pH values into methyl isobutylketone containing 4-capryl-1-phenyl-3-methylpyrazolone-5 (PMCPyP) was investigated. The quantitative extraction of Fe^{+3} , Y^{+3} , In^{+3} , Sc^{+3} , Sb^{+3} , rare earths, Ca^{+2} , Sr^{+2} , Cd^{+2} , Zn^{+2} , Co^{+2} , and Mn^{+2} was utilized for devising radiochemical procedures for the carrier-free separation of ^{54}Mn , ^{58}Co , ^{59}Fe , ^{45}Ca , ^{89}Sr , ^{115}Cd , and ^{90}Sr produced by $^{54}\text{Fe}(n,p)^{54}\text{Mn}$, $^{58}\text{Ni}(n,p)^{58}\text{Co}$, $^{59}\text{Co}(n,p)^{59}\text{Fe}$, $^{45}\text{Sc}(n,p)^{45}\text{Ca}$, $^{89}\text{Y}(n,p)^{89}\text{Sr}$, $^{235}\text{U}(n,f)^{115}\text{Cd}$, and $^{235}\text{U}(n,f)^{90}\text{Sr}$ reactions and also for the separation of ^{140}La from $^{140}\text{Ba} - ^{140}\text{La}$, ^{90}Y from $^{90}\text{Sr} - ^{90}\text{Y}$, Sr from Sr-Ba, and ^{115m}In from $^{115}\text{Cd} - ^{115m}\text{In}$ mixture, respectively. More than 90% added or calculated activities with a good decontamination factor were recovered. (auth) (DENMARK)

39151 METHOD OF PREPARATION OF ^{137}Ba . Bonnin, Andre Marie Alain; Yordamian, Stefane Gerard Ahtonin (to Saint Gobain Techniques Nouvelles). British Patent 1,080,454. Aug. 23, 1967. Priority date Nov. 8, 1963, France.

A method of preparing ^{137}Ba starting from ^{137}Cs is described. The method is characterized by successive stages of ^{137}Cs fixation on solid ferrocyanides of transition elements ($21 \leq Z \leq 29$). The ^{137}Ba is eluted from the fixed ^{137}Cs using NaCl solutions containing calcium gluconate and calcium levulinate. (J.R.D.)

36095 SEPARATION OF IODINE FROM FISSION PRODUCT SOLUTIONS WITH SILVER CHLORIDE ON SILICA GEL. Lieser, K. H.; Hild, W. (Technische Hochschule, Darmstadt, Ger.). *Radiochim. Acta*, 7: 74-7 (June 1967). (In German).

The iodine produced by the fission of uranium was separated in a carrier-free form from nearly all other fission products by the use of columns filled with silver chloride on silica gel. The yields of carrier-free iodine varied about 90%. By adding very small amounts of carrier the yield could be increased to about 98 to 99% with better reproducibility. (auth)

30497 (EUR-3475.f) RECUPERATION DU ^{90}Sr PAR EXTRACTION LIQUIDE-LIQUIDE A PARTIR DES SOLUTIONS CONCENTREES DE PRODUITS DE FISSION, 1960-1965. (Recovering ^{90}Sr by Liquid-Liquid Extraction From Concentrated Fission-Product Solutions, 1960-1965). Galaud, G.; Lefevre, J. (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucleaires); Serrini, G. (European Atomic Energy Community). May 1967. 99p. (In French). Dep.

Known processes for recovering Sr-90 by extraction with bis (2-ethylhexyl)phosphoric acid. Owing to the determination of large amounts of magnesium in the fission-products solution, the process had to be completely replanned. A new, original scheme is described, its key operation being a magnesium pre-treatment. The rare earths are first extracted at pH 2, which is virtually unaffected by the magnesium. The overall fission-product decontamination factor as regards strontium was substantially lowered (DF 10-20) and a further stage for purifying strontium with respect to magnesium was necessary. (auth)

20048 (EUR-3451.f) RECUPERATION DU ^{137}Cs DANS LES SOLUTIONS DE PRODUITS DE FISSION PROVENANT DES ALLIAGES URANIUM-MOLYBDENE. (Recovery of ^{137}Cs From Uranium-Molybdenum Alloy Fission Product Solutions). Auberlin, Ch.; Lefevre, J.; Raggenbass, A. (Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 2, 1967. 42p. (In French). Dep.

The use of uranium-molybdenum alloys in power reactors influences the concentration of the aqueous extraction phases containing fission products. When added during concentration, phosphoric acid has the effect of combining with the molybdenum to form the more soluble phosphomolybdic acid; this enables the desired concentration factors to be reached. During this phase, the cesium precipitates as cesium phosphomolybdate, and zirconium as a phosphate. However, the cesium can still be recovered from the precipitate by alkaline treatment, which renders the cesium salt soluble and allows zirconium oxide to remain in the precipitate. The cesium phosphomolybdate is reformed by acidification of the alkaline solution, the treatment being continued by the conventional process of separating the cesium-137 by phosphotungstic acid. (auth)

32224 (EUR-3473.f) RECUPERATION DU CAESIUM 137 PAR PRECIPITATION DE PHOSPHOTUNGSTATE. (Recovering ^{137}Cs by Phosphotungstate Precipitation). Lefevre, J.; Auberlin, C. (Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1967. 29p. (In French). Dep.

The full process is described, as tested on inactive synthetic fission products in a semi-industrial scale pilot plant equipped with a centrifuging settler. The process was laboratory-developed with the aid of radioactive tracers, and was designed to afford the maximum restriction of cesium waste in the effluents. With this object a certain number of internal recyclings and an initial decontamination stage were planned and tested, and these admit a waste of value in the effluents of less than 10^{-4} of the treated cesium. (auth)

32236 RECOVERY OF RADIOACTIVE CESIUM FROM REPROCESSING SOLUTIONS BY MEANS OF AN INORGANIC ION-EXCHANGER. Balon, G.; Beaudet, C. A.; Piret, J.; Ruston, W. R. (Societe d'Etudes de Recherches et d'Applications pour l'Industrie, Brussels). Kerntechnik, 9: 258-61 (June 1967). (In German).

The physical properties and the ion-exchange capacities of tin phosphate and of titanium phosphate are presented. It is shown that tin phosphate selectively adsorbs cesium ions from strongly acid solutions and therefore makes possible the separation of ^{137}Cs from radioactive reprocessing solutions of spent nuclear fuel elements. The adsorption and elution yields obtained in a series of experiments with titanium phosphate showed that this inorganic ion exchanger can be used for an industrial process. (auth)

38997 (EUR-3299.f) LA RECUPERATION DES PRODUITS DE FISSION. Rapport Final Octobre 1962-Avril 1966. (Recovery of Fission Products. Final Report, October 1962-April 1966). (Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1967. 62p. (In French). Dep.

Results obtained from more than three years of study on the recovery of fission products from waste solutions available in France are reviewed. Techniques used for the analysis of fission-products solution are outlined. The separation of ^{137}Cs and ^{90}Sr was studied. The ion-exchange technique using mineral exchangers was the most satisfactory. With mineral ion exchangers the mother solution could be processed without modification. Techniques for the separation of the rare earths were also studied. A pilot plant for the separation of ^{137}Cs was designed and is being constructed. (J.S.R.)

34321 (ORNL-tr-1717) SEPARATION OF ^{152}Eu , ^{241}Am , AND ^{246}Cm BY ELECTROPHORETIC FOCUSING, USING SODIUM POLYPHOSPHATE AS COMPLEXING AGENT. Marcu, Gheorghe. Translated for Oak Ridge National Lab., Tenn., from Stud. Univ. Babes-Bolyai, Ser. Chem., 11: No. 2, 61-6 (1966). 9p. Dep. CFSTI. JCL \$1.10 fs, \$0.80 mf.

The separation of some rare earths (^{152}Eu , ^{147}Pm) and of some transuranium elements (^{241}Am , ^{246}Cm) using as a complexing agent sodium polyphosphate at various concentrations by the electrophoretic focusing method is described. The experiments were carried out on No. 4 Whatman paper at a potential difference of ~900 V. The duration of separation was 8 minutes. The best separations were obtained when using the sodium polyphosphate at ~0.02M. 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 did not separate from ^{241}Am except at pH ~7.0, when the distance between their concentration zones is 8 mm. In the presence of europium and promethium the effectiveness of this separation increases to 14 mm. For group separation of the transuranium elements from rare earths, the best results were obtained at pH ~2.45, when the distance between zones is 12 mm. (auth)

Actinides

28050 (JAERI-1132) STUDIES ON THE SOLVENT EXTRACTION OF ACTINIDE ELEMENTS BY ORGANOPHOSPHORUS COMPOUNDS. Watanabe, Kenju (Japan Atomic Energy Research Inst., Tokyo). Nov. 1966. 95p. Dep.

A radiochemical survey was made on the extraction of actinide elements by TBP, TBPO, and TOPO from hydrochloric and nitric acid solutions. In general, most of the elements studied were more extractable in the extraction systems of phosphine oxides than in those of phosphate. Influence of the variation of acid concentration on the distribution ratio of the elements was more remarkable in the former system than in the latter. The extraction of thorium and uranium chlorides by TBP or TOPO was studied. The composition of complexes extracted from the chloride solution of low acid concentration was established by partition study to be $\text{UO}_2\text{Cl}_2(\text{TOPO})_2$, $\text{UCl}_4(\text{TOPO})_2$, $\text{ThCl}_4(\text{TOPO})_2$, and $\text{UCl}_4(\text{TBP})_2$. The composition of thorium complex in the TBP phase free from hydrochloric acid was revealed by infrared study to be $\text{ThCl}_4(\text{TBP})_4$. A study on the extraction of curium from nitrate solution by TOPO suggested that the composition of the complex extracted was $\text{Cm}(\text{NO}_3)_3 \cdot (\text{TOPO})_3$. The results obtained in the extraction of individual elements were applied to the separation of specific mixtures. Small amounts of uranium-233 were separated from irradiated thorium by extraction with TBPO. Uranium and plutonium were separated from each other by a continuous fractional extraction method using a couple of small pulse columns. Reversed phase column chromatography was applied to the separation of americium from rare earths after coprecipitation. HDEHP and TOPO-xylene solutions held on kieselguhr were used as the stationary phase and the elutions were carried out with 0.1 to 1N nitric acid solutions. In the HDEHP system, americium was effectively separated from the rare earths except from praseodymium. Americium could also be separated from europium in the TOPO system. (P.C.H.)

32250 USE OF ORGANIC COPRECIPITATIONS FOR CONCENTRATION OF ACTINIDE ELEMENTS. Akimova, T. G. Radiokhimiya, 9: 206-15 (1967). (In Russian).

A review is given of organic coprecipitant used for the concentration of actinide elements. (tr-auth)

40786 CHROMATOGRAPHIC SEPARATION OF ^{242}Cm AND ^{241}Am AND THE SPECTROSCOPIC DETERMINATION OF THEIR α ACTIVITY. Auer-Welsbach, Helga; Bildstein, H.; Muellner, P. (Institut fuer Chemie, Vienna). Monatsh. Chem., 98: 61-7 (1967). (In German).

The separation of ^{242}Cm from ^{241}Am on the ion-exchange resin Dowex 50 W $\times 8$ with α -hydroxyisobutyrate solutions is described. The elution positions were marked by the use of Sm and Pm as indicators; the elution order is Sm-Cm-Pm-Am. Elution curves are given for 0.25M $(\text{NH}_4)_2\text{H}_2\text{O}_2$ hydroxyisobutyrate, where $x = 0.60$ for Sm, 0.65 for Cm, Pm, and Am, and 0.70 for tail fractions containing Nd. Drop and molecular plating samples were prepared for measuring α activities with semiconductor detectors. About 2×10^{-8} g ^{241}Am yielded 4×10^{-8} g ^{242}Cm on activation for 400 hr; the latter corresponded to 99.5% of the total observed activity. Representative spectra of drop and plating probes for a fraction are illustrated. (BBB)

25912 SEPARATION OF PURE ^{223}Fr FROM ^{227}Ac ON A SEPARATION COLUMN. Lieser, K. H.; Kluge, E. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 7: 3-9 (Mar. 1967). (In German).

Pure ^{223}Fr can be separated from all the other decay products of ^{227}Ac in one operation. The ^{227}Ac is fixed on a Dowex-50 column. This column is followed by a second column containing silica gel covered with BaSO_4 . The elution is carried out with a chromate containing solution of ammoniumchloride. BaCrO_4 on silica gel can also be used instead of BaSO_4 on silica gel. This separation method yields about 90% of the ^{223}Fr ; the radiochemical purity is better than 99.9%. (auth)

40944 (BLG-422) SEPARATION OF ^{226}Ra , ^{227}Ac , AND ^{228}Th BY ION EXCHANGE. Huys, D.; Baetsle, L. H. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). May 1967. 8p. Dep.

Relying on the particular properties of synthetic organic ion exchange resins in concentrated HClO_4 a separation method for radium-actinium-thorium has been developed. Radium is eluted in 12 M HClO_4 , actinium is washed by 3 M HNO_3 , and finally thorium is eluted by 3 M H_2SO_4 . Since organic ion exchangers are used the method is only suited for analytical separations. A new method making use of titanium phosphate as ion exchanger (ABEDEM-Ti-A) has been worked out. Thorium is absorbed on titanium phosphate in 4M HNO_3 and radium can be trapped in 2M HNO_3 . Actinium is not fixed in these media and emerges radiochemically pure at the end of the second column. Separations with milligram quantities of ^{226}Ra , ^{227}Ac , and ^{228}Th have proven to be successful. Full-scale operations at the multicurie level are possible with this new method. (auth)

40977 THE SEPARATION OF $^{210}\text{Po}(\text{RaF})$ BY COPRECIPITATION WITH TANNIC ACID. Zsoldos, Tibor; Csovari, Sophia; Banyai, Jozsef. Magy. Kem. Foly., 73: 307-10 (July 1967). (In Hungarian).

A method for separation of ^{210}Po from aqueous solutions is reported. In addition to Te-carrier coprecipitation, ^{210}Po was also precipitated in the form $\text{Te}(\text{Po})$ galloylgallate. After dissolution of the precipitate the ^{210}Po was separated from the solution by spontaneous deposition on Ni disks. The dependence of ^{210}Po deposits on deposition time and a correction factor on account of volume losses during deposition were determined. The yield amounted to $80 \pm 5\%$. (tr-auth)

23934 PREPARATION OF $^{234}\text{Pa}(\text{UZ})$ AND $^{234m}\text{Pa}(\text{UX2})$ SOURCES WITH HIGH SPECIFIC ACTIVITY. Bouissieres, Georges; Legoux, Yvette; Merinis, Jean; Muxart, Roland; Ossart, Pierre; Vernois, Jacques (Institut de Physique Nucleaire, Orsay, France). Bull. Soc. Chim. France, No. 3, 934-6 (Mar. 1967). (In French).

A two-stage procedure to obtain ^{234}Pa and ^{234m}Pa is described. The first step is a separation of a few milligrams of thorium from about one hundred kilograms of uranium by extracting with tributyl phosphate. The second step is a thorium-protactinium separation by vaporizing chlorides inside a tube with a temperature gradient. The very high specific activity of ^{234}Pa sources is convenient for studying spectra of conversion electrons of this nuclide. (auth)

34102 STUDIES OF ACTINIUM(III) IN VARIOUS SOLUTIONS. I. SEPARATION AND PURIFICATION OF ^{228}Ac IN ^{228}Ra SOLUTIONS BY SOLVENT EXTRACTION METHOD. Sekine, Tatsuya; Kolke, Yasuaki; Sakai, Mitsuo (Tokyo Coll. of Science). J. Nucl. Sci. Technol. (Tokyo), 4: 308-11 (June 1967).

A solvent extraction method using a mixture of 0.1M thenoyltrifluoroacetone and 0.1M tributyl phosphate in carbon tetrachloride was developed for the separation and purification of ^{228}Ac in ^{228}Ra solutions. The ^{228}Ra was first purified by a preliminary extraction cycle. The ^{228}Ac that accumulated in this ^{228}Ra fraction after the purification was separated and purified by a second solvent extraction cycle. Since commercially available ^{228}Ra solution very often contains ^{226}Ra , the γ decay products of ^{228}Ra have to be carefully removed. The ^{228}Ac thus prepared was found to be pure enough for use as tracer. (auth)

25908 SEPARATION AND PREPARATION OF ^{238}Pu FROM NEUTRON IRRADIATED ^{237}Np TARGET. APPLICATION OF TIOA-HCl SYSTEM SOLVENT EXTRACTION METHOD. Sakano, Masanobu; Osawa, Masumi; Miyaji, Nobuyoshi (Kanazawa Univ., Japan). Nippon Genshiryoku Gakkaishi, 9: 138-45 (Mar. 1967). (In Japanese).

In order to study the abundance and distribution of plutonium in natural samples, tracers are required to determine the recovery of the element after the many stages of separation and preparation applied to the counting source. For this purpose α -emitting ^{238}Pu was chosen; it was separated into carrier-free state from thermal neutron-irradiated ^{237}Np target by solvent extraction using triisobutylamine. In order to ascertain complete separation of the plutonium from neptunium and protactinium, the oxidation and reduction of plutonium in hydrochloric acid solutions and the extraction behavior of plutonium at different oxidation states were studied. Results of α spectrometry on the ^{238}Pu thus obtained proved it to be pure enough to be used for determination of ^{239}Pu . (auth)

32248 AMALGAM METHOD OF SEPARATION OF EUROPIUM FROM LANTHANUM, CERIU, PRASEODYMIUM, AND NEODYMIUM. Cayun, M. G.; Timofeeva, T. G. Radiokhimiya, 9: 261-3 (1967). (In Russian).

By use of ^{152}Eu , an amalgam method for the separation of Eu from La, Ce, Pr, and Nd with control of the potential was studied. The effects of temperature and current density on the efficiency of the separation are explained. A hypothesis on the possible formation in the mercuric phase of intermetallic compounds of Eu with cerium metals was developed. (tr-auth)

Labeled Materials

30635 (SGAE-IB/IA-16/1967) LABELLING OF OIL BY COLLOIDAL ^{198}Au FOR TRACER STUDIES. Donhoffer, D. K.; Duftschmid, K. E. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Selbendorf). 1967. 8p. Dep.

A simple method for labeling oil with colloidal gold-198 was developed and tested. The advantage over other methods is the high specific activity of the tracer which can be achieved. The stability of colloidal gold in oil was investigated in several tests and found to be sufficient for the most applications. (auth)

24062 (EUR-3169.f) ETUDE SUR L'UTILISATION DES RADIOISOTOPES POUR LE MARQUAGE DES MATERIAUX REFRACTAIRES UTILISES EN FONDERIE. (Study of the Use of Radioisotopes for Labeling Refractory Material Used in Foundry). Descamps, Cl.; Delporte, E. (Societe Belge pour l'Industrie Nucleaire, Brussels); Berger, R.; Nicolaidis, P.; Jassogne, L. (Usines Emile Henricot, S. A., Court-St.-Etienne (Belgium)). Nov. 1966. Contract 011-62-12 IRAB. 120p. (In French). Dep.

The development of practical methods to be used by metalcasters for control and detection of exogenic inclusions in castings without demolishing them, in opposition with other methods is described. As to the type of casting accessory, two labeling methods were used, both utilizing zirconium-95 as a tracer. For the casting accessories in moulding sand a "dry" method has been used, consisting of mechanically mixing with sand, zircon previously irradiated in a reactor. For casting accessories in the form of well determined refractory pieces, a "wet" method was used to introduce the tracer into those elements. The tracer, in the form of a zirconium nitrate solution, is sprayed on the refractory by means of an apparatus especially conceived for this purpose. The pieces undergo a thermal treatment transforming the zirconium nitrate into oxide. Different metallic pieces were cast by means of those labeled accessories. The inclusions have been detected without difficulty by passing a scintillator over the pieces. The two methods proved very practical in use and the sensitivity of detection permits an easy locating of inclusions from about 15 mg. inserted in 3 mm thick steel. (tr-auth)

35988 (EUR-3496.f) PREPARATION DE MOLECULES MARQUEES PAR IRRADIATION GAMMA. Rapport Final. (Preparation of Labelled Molecules by Gamma Irradiation. Final Report). Constant, R.; Lecoq, R.; Provoost, F.; Vasilescu, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). July 1967. Contract 085-64-11 RISB. 76p. Dep.

Under the influence of gamma irradiation of the $\text{CO}_2\text{-CH}_4$ mixture, various substances form, which can be divided into three phases: the condensable phase at -78°C , containing some twenty substances with different organic functions; the noncondensable phase at -78°C , in which the main substances formed are ethane and carbon monoxide; and the polymer phase of the "polyketene" type. Gas-phase chromatography was used for identifying and analyzing the substances formed, which are condensable and noncondensable at -78°C . Infrared spectroscopy was employed for analyzing the polymer fracture. When using $^{14}\text{CO}_2$, the labeled compounds were detected by means of an ionization chamber together with the chromatography equipment. Two of the substances formed during radiolysis of the $\text{CO}_2\text{-CH}_4$ system are of particular interest, i.e., acetone and methylethylketone, which represent about 75% of the phase condensable at -78°C . On the basis of this observation, the influence of certain parameters (molar ratio, pressure, total dose absorbed, temperature, and presence of solid or gaseous additives) on the radiolysis of the $\text{CO}_2 + \text{CH}_4$ mixture was studied. The ketone formation yields were improved; they followed an ascending curve in the order of irradiation techniques shown below: homogeneous-phase irradiation: low pressure (<20 atm); homogeneous-phase irradiation: high pressure (>40 atm); irradiation in the presence of solid additives (low pressure); and irradiation in the presence of gaseous additives (high pressure). An optimum acetone and methylethylketone yield was obtained by irradiating, at room temperature and a dose of 10 Mrads, a $\text{CO}_2\text{-CH}_4$ mixture (molar ratio 3:1) at a partial pressure of 40 atm and in the presence of 50% xenon. When considering the mechanisms governing the formation and radiolysis of ethane and acetone, radiolysis of the latter compound was shown to be very substantial. The possibility of applying this study to the production of acetone is prompted by irradiation of the $^{14}\text{CO}_2\text{-CH}_4$ mixture. (auth)

38961 (JAERI-4041) PRODUCTION OF ^{35}S AND PREPARATION OF ITS INORGANIC LABELLED COMPOUNDS. A REVIEW OF METHODS. Shikata, Eiichi (Japan Atomic Energy Research Inst., Tokyo). July 1965. 7p. (In Japanese). Dep.

Methods of producing carrier-free ^{35}S from neutron-irradiated potassium chloride and methods of preparing inorganic labeled compounds of ^{35}S are reviewed. The quantity of sulfur compound used as labeled compound and the usefulness for further synthesis-process was considered. Sulfite, thiosulfate, sulfide, thiocyanate, and elementary sulfur were the sulfur compounds considered. (auth)

30442 (EUR-3282.d) NEUBILDUNG MARKIERTER MOLEKULE BEI DER URANSPLATUNG. (Formation of Labelled Compounds under Neutron Irradiation). Born, J. H. (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). 1967. 19p. (In German). Dep.

Experiments involving the neutron irradiation of benzene chromium tricarbonyl are presented. The results show that chromium hexacarbonyl was formed as the preferential reaction product after the (n,γ) process. The dependence of the reaction product yields on the irradiation temperature and on annealing was determined. Discussion of the data thus obtained revealed clearly that not free chromium atoms, but rather chromium atoms containing carbonyl groups, are mainly formed during the primary reaction, thus impeding the formation of dibenzene chromium. An account is given of studies on the chemical reactions that take place after isomeric transitions. A mixture of the isomeric pair $^{80m}\text{Br}/^{80}\text{Br}$ was produced by the neutron reduction of bromine and mixed with halogen benzolene. Gas-chromatographic analysis in conjunction with activity determinations suggests that it is not only the ^{80}Br atoms from the isomeric transition which cause substitute reactions but that inactive bromine also plays a major part in these reactions, and the necessary energy can apparently only come from the isomeric transitions. (auth)

Generators

36015 ^{99m}Tc TECHNETIUM GENERATOR USING SALINE SOLUTION. El Garhy, M.; El Bayoumy, S.; El Alf, S. (Atomic Energy Establishment, Cairo). Radiochim. Acta, 7: 163-4 (June 1967).

The direct production of ^{99m}Tc preparation by milking with a saline solution is described. Molybdenum trioxide was irradiated at a thermal neutron flux of 0.5 to 1.5×10^{13} n/cm²sec. The irradiated target was dissolved in NaOH, a solution of Br₂ and concentrated HCl was added, the mixture warmed, and NaH₂PO₄ solution added. It was run into a column filled with alumina. The ^{99m}Tc generated was milked at 24 hr intervals using an 0.9% NaCl solution. Milking ^{99m}Tc took only 5 to 10 min and up to 90% of the total milked activity was found in the first 15 ml of the effluent. The efficiency of milking ranged between 75 and 85%. The radiochemical purity, obtained from gamma spectrum and decay curves measurements, was better than 99.99%. (D.H.M.)

ISOTOPE TECHNOLOGY DEVELOPMENT

Activation Analysis

Gamma and Charged Particles

30362 ACTIVATION ANALYSIS OF TITANIUM BY MEANS OF THE (γ,p) REACTION. I. ACTIVATION ANALYSIS OF TITANIUM IN IRON BY PHOTONUCLEAR REACTION. Abe, Shigeki (Yamagata Univ., Japan). Nippon Kagaku Zasshi, 87: 710-4 (July 1966). (In Japanese).

30363 ACTIVATION ANALYSIS OF TITANIUM BY MEANS OF THE (γ,p) REACTION. II. PHOTOACTIVATION OF VANADIUM AND ITS APPLICATION FOR THE DETERMINATION OF TITANIUM IN VANADIUM. Abe, Shigeki (Yamagata Univ., Japan). Nippon Kagaku Zasshi, 87: 714-7 (July 1966). (In Japanese).

An investigation of the photonuclear reaction of V was carried out to obtain the yield for the reaction $^{51}\text{V}(\gamma, \alpha)^{47}\text{Sc}$. Vanadium oxide was irradiated for an hour with a 20-MeV bremsstrahlung generated from a linear electron accelerator. The γ spectrum of irradiated V showed a prominent photopeak at 0.16 MeV, which was attributed to ^{47}Sc ($T_{1/2} = 3.43$ day) produced by the (γ,α) reaction. For calculation of the yield of ^{47}Sc , the ^{56}Mn activity produced by the (γ,p) reaction from Fe was used as an internal monitor of photon flux intensity. The relative yield of ^{47}Sc from $^{51}\text{V}(\gamma, \alpha)^{47}\text{Sc}$ was found to be 35.6 ± 0.6 with 20 MeV bremsstrahlung. A method for nondestructive determination of Ti in V was shown. Titanium content in V₂O₅-TiO₂ mixtures can be determined to ~1% by using ^{56}Mn as a photon flux monitor. (NSA of Japan)

22008 YIELDS OF RADIOACTIVITIES INDUCED BY (γ,n) REACTIONS WITH 20-MeV BREMSSTRAHLUNG. Oka, Yoshinaga; Kato, Toyooki, Nomura, Koichi, Saito, Tatsuya (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 40: 575-9 (Mar. 1967).

The yields of radioactivities resulting from the (γ,n) reactions on 37 elements covering the periodic table were determined by means of 20-MeV linear accelerator bremsstrahlung and gamma spectrometry. The yield values, as measured in the number of photodisintegrations per mole per roentgen for each of the (γ,n) reactions, increase in the main regularly with atomic number from 10^3 through 10^7 order of magnitude. Anomalously small yield values are obtained in the irradiation of the nuclides with neutron or proton number of the magic numbers. The present results permit studies of general behavior of the photoneutron reactions and of the application of their products to the photoactivation analyses of many elements distributed throughout the periodic table. (auth)

38897 STUDIES ON ESTIMATION OF ELEMENTS BY GAMMA IRRADIATION. Asai, Takuo; Azuma, Toshio (Radiation Center of Osaka Prefecture). Annu. Rep. Radiat. Center Osaka Prefect., 6: 115 (Mar. 1966).

A method is described for the estimation of elements contained in insoluble materials by irradiating the materials in water with γ rays and then filtering. A sample of the water is evaporated on filter paper, and analyzed by neutron activation. (B.L.M.)

38886 PHOTONEUTRON METHOD OF ISOTOPIC ANALYSIS OF HYDROGEN IN NATURAL WATERS. Khristianov, V. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Isotopenpraxis, 3: 235-7 (June 1967). (In Russian).

A photoneutron method for determining the deuterium content in liquid samples is described. The neutrons to be measured are produced by the reaction D(γ,n)H. The method proposed is more simple and rapid than the densitometric ones, but has the same accuracy. The effects of Cd, B, and Cl in the sample on the results of measurements are discussed. (auth)

35467 PHOTOACTIVATION OF RARE-EARTH ELEMENTS WITH 20-MeV BREMSSTRAHLUNG. Oka, Yoshinaga (Tohoku Univ., Sendai); Kato, Toyooki; Nagai, Iwao. J. Nucl. Sci. Technol. (Tokyo), 4: 300-7 (June 1967).

The oxides of scandium, yttrium and all elements from lanthanum through lutetium, except promethium, were irradiated for 1 hr with bremsstrahlung γ rays converted from a 20-MeV electron beam; and the radioactive species produced as a result were examined on the basis of photonuclear reactions, their yields, and their applicability to activation analyses. The sensitivity and selectivity of the proposed method are discussed from the data thus obtained. The (γ,n) reaction was predominant for most elements, and at least 28 product nuclides have been identified. A number of other (γ,2n) reactions were also observed. The yields of the (γ,n) reactions were estimated for the lanthanide rare earths through measurement of the resultant activity to be about 10^7 /mole · R and somewhat more than 10^5 smaller for the corresponding (γ,2n) reaction. Reactions with charged-particle emission contributed only a small fraction in the observed radioactivity. Extraneous activity arising from neutron capture was also measured; these activities could be reduced considerably by encasing the sample in boron. The lower limits of detection averaged about 1 μg for most of the rare-earth elements. (auth)

38880 ACTIVATION ANALYSES OF RUTHENIUM IN OSMIUM AND IN RHODIUM BY MEANS OF PHOTONUCLEAR REACTION. Oka, Yoshinaga; Kato, Toyooki; Saito, Tatsuya (Tohoku Univ., Sendai). Nippon Kagaku Zasshi, 88: 866-71 (Aug. 1967). (In Japanese).

Methods of photoactivation analyses were studied for the determinations of Ru in Os and in Rh. The irradiations were performed for 1 hr with 20-MeV bremsstrahlung radiation generated from a linear electron accelerator. Ru can be determined by measuring either the 0.340-MeV γ of ^{95}Ru or the 0.762 MeV γ of ^{95}Tc . The matrix Os or Rh was used as an internal monitor of the bremsstrahlung radiation dose to which the sample was exposed. The accuracy of the method was investigated by irradiating the mixtures of Ru and Os or Ru and Rh with known weight ratios. The activity ratios of ^{95}Ru to ^{185}Os were found to be proportional to the weight ratios of the Ru to Os. Similarly, a linear relation was obtained between the ratios of ^{95}Tc to ^{102}Rh activities and the ratios of the Ru to Rh weights. Relative standard deviations of less than ±5% were attained. Ru concentrations down to about 0.01% in Os or about 0.03% in Rh may be determined nondestructively by this method. (auth)

38881 ³² ACTIVATION ANALYSES OF SEVERAL MIXED RARE EARTH ELEMENTS BY MEANS OF PHOTONUCLEAR REACTION. Oka, Yoshinaga (Tohoku Univ., Sendai); Kato, Toyooki; Nagai, Iwao. *Nippon Kagaku Zasshi*, 88: 871-5 (Aug. 1967). (In Japanese).

Nondestructive methods of analyses for Ce in La, Gd in Tb, and Tm in Er were developed based on the formation of the radioactive species induced by the (γ, n) processes in these elements. The irradiations were performed for 1 hr with 20-MeV bremsstrahlung radiation generated from a linear electron accelerator. CeO_2 - La_2O_3 , Gd_2O_3 - Tb_4O_7 , and Tm_2O_3 - Er_2O_3 mixtures of known compositions were used for checking the accuracies of the methods by means of γ spectrometric measurements. La_2O_3 and Tb_4O_7 were favorable matrices for nondestructive determinations of CeO_2 and Gd_2O_3 , respectively. A linear relation was attained between the photopeak yield of 0.166-MeV γ from ^{139}Ce and the CeO_2 content of the samples. CeO_2 in La_2O_3 down to about 5 μg can be determined by this method. Similarly, Gd_2O_3 in Tb_4O_7 down to about 2 μg can be determined by measuring the 0.363-MeV γ photopeak of ^{159}Gd . For Tm_2O_3 analysis, the matrix Er was used as an internal monitor of bremsstrahlung radiation dose rate, and the activity ratio of the ^{189}Tm (0.198 MeV γ) to ^{181}Er (0.826 MeV γ) was compared with a known weight ratio of Tm_2O_3 to Er_2O_3 in the sample. A content of 0.01% Tm_2O_3 in Er_2O_3 matrix may be determined by this method (auth).

21896 ACTIVATION ANALYSIS BY γ PHOTONS AND CHARGED PARTICLES. Albert, Philippe (CNRS, Vitry, France). *Chimia (Aarau)*, 21: 116-25 (Mar. 15, 1967). (In French).

Some results of a study of the possibilities in activation analysis using γ photons and charged particles are reported. The conditions for (γ, n) activation of oxygen, nitrogen, and carbon in trace analysis are given and the possibilities of γ activation analysis for some other elements are discussed. Attention is drawn to the interest of developing charged-particle activation analysis not only for gases (O, N, C) but also for boron, titanium, iron, and a large number of other elements. A study on oxygen activation analysis in aluminum is reported as an example that may show how the best conditions for a charged particles activation analysis in one particular material can be found. (auth)

25777 MICROANALYSIS OF FLUORINE IN ZIRCALOY BY THE USE OF THE $^{19}\text{F}(p, \alpha\gamma)^{16}\text{O}$ REACTION. Moeller, E.; Starfelt, N. (Aktiebolaget Atomenergi, Studsvik, Sweden). *Nucl. Instrum. Methods*, 50: 225-8 (1967).

A method of determining fluorine contamination on and below the surface of Zircaloy by means of proton irradiation using a Van de Graaff accelerator and the detection of prompt gamma radiation from the $^{19}\text{F}(p, \alpha\gamma)^{16}\text{O}$ reaction was studied. Formulas for deriving depth distributions of impurities from the measured counting rate were derived. The influence of energy straggling on the depth resolution was studied. Both the total amount and the depth distribution were measured on samples which have undergone different treatments. Because of the high yield from the reaction used, a quantity of fluorine less than 0.01 $\mu\text{g}/\text{cm}^2$ can be detected by this method. (auth)

28140 ANALYTICAL BETA IRRADIATION DEVICE. Fukai, Junichiro (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-11120. May 24, 1966. Filed Mar. 6, 1963.

In the analytical β -ray irradiation device proposed, a beta ray focusing cylindrical body is provided that includes a beta source, a sample material irradiated with the beta rays, a detector for the characteristic x-rays from the irradiated material, and a beta ray focusing cylindrical body located in the path of beta rays (from the source to the sample material), which also shields the beta rays from foreign magnetism. (NEA of Japan)

25778 MICROANALYSIS OF LIGHT ELEMENTS BY MEANS OF (d, n) REACTIONS. Moeller, E.; Nilsson, L.; Starfelt, N. (Aktiebolaget Atomenergi, Studsvik, Sweden). *Nucl. Instrum. Methods*, 50: 270-6 (1967).

A method of determining impurities of carbon, nitrogen, and oxygen on and below steel surfaces by means of (d, n) reactions has been developed. The steel samples were irradiated by 3-MeV deuterons from a Van de Graaff accelerator and the spectra of the neutrons emitted in (d, n) reactions in the impurities were measured. These spectra contain information about the amount and the depth distribution of the impurities. The sensitivity was 0.1 $\mu\text{g}/\text{cm}^2$ and the depth resolution 4500 Å. Both these figures can be improved considerably. (auth)

40800 APPLICATION OF INELASTIC PROTON SCATTERING TO THE RAPID DETERMINATION OF SILICON IN STEELS. Pierce, T. B.; Peck, P. F.; Cuff, D. R. A. (Atomic Energy Research Establishment, Harwell, Eng.). *Anal. Chim. Acta*, 39: 433-6 (Dec. 1967).

A rapid, nondestructive method for determining silicon in steels was developed based on the measurement of the 1.77-MeV γ -line emitted by the proton inelastic scattering reaction $^{28}\text{Si}(p, p')^{28}\text{Si}$. For some of the determinations the 0.84-MeV γ -line from the reaction $^{56}\text{Fe}(p, p')^{56}\text{Fe}$ was used as internal standard. (auth)

45037 ASSAY OF BERYL BY PHOTONEUTRON METHOD. Rai, Lalpat; Dayal, Narendar; Bhatnagar, A. S. (Dept. of Atomic Energy, New Delhi). *Indian J. Pure Appl. Phys.*, 5: 183-4 (May 1967).

Quantitative determination of Be in beryl samples was done by measuring the neutron flux produced on irradiating the sample with γ rays from ^{124}Sb . The neutrons thus produced were thermalized in a paraffin wax block and detected by four BF_3 counters. A comparison of the results of BeO contents of 44 samples, determined by the photoneutron method as well as the chemical method, showed a very good correlation. This procedure, therefore, provides a very reliable, quick, and nondestructive method of detecting the presence of beryl and determining its BeO content quantitatively. (auth)

40777 USE OF γ -PHOTONS AND CHARGED PARTICLES FOR DETERMINING VERY LOW TRACES OF B, C, N, AND O. Engelmann, Ch. (CEN, Saclay, France). *Bull. Soc. Chim. France*, No. 7, 2316-20 (July 1967). (In French).

Current possibilities of using charged particles and γ photons in the field of trace analysis of elements such as B, C, N, and O are reviewed from experimental data. Available irradiation methods are briefly described. Then the main useful nuclear reactions, as well as possible interference effects, are reviewed. Examples of applications are given for nondestructive analyses in various materials. Minimum measurable quantities of B, N, C, and O are reported for the procedures described. (auth)

40775 ACTIVATION ANALYSIS OF TRACES OF THE LIGHT ELEMENTS IN HIGH PURITY MATERIALS EMPLOYING GAMMA PHOTONS AND CHARGED PARTICLES. Engelmann, Ch. (Centre d'Etudes Nucleaires, Saclay, France). *Int. J. Appl. Radiat. Isotop.*, 18: 569-78 (Aug. 1967). (In French).

Research on the determination of B, C, N, and O in concentrations $<10^{-8}$ by activation analysis is described. Irradiation facilities include a 45-MeV linear accelerator, a fixed energy cyclotron giving 44-MeV alpha particles, and a variable energy cyclotron capable of giving d, p, and ^3He particles of 3 to 30 MeV. Results concerned with improvements of methods using oxidative or reduction fusion for separation of the isotopes usually obtained by activation of the impurities (viz. ^{11}C , ^{13}N , ^{15}O) are presented, and methods are described allowing determinations to be made in a few minutes. The possibilities of the use of the different particles are discussed, and in particular the importance of choice of nuclear reactions in regard to nature of the matrix and of the impurity, and the quantity of this impurity and others present in the irradiated sample. Some specific examples are described. (UK)

45056 DETERMINATION OF BERYLLIUM BY MEANS OF A PHOTONEUTRON SETUP WITH CROWN COUNTERS. Meshchobskaya, Kh. B.; Ryzhkov, N. N. *Zh. Anal. Khim.*, 22: 1328-32 (Sept. 1967). (In Russian).

A photoneutron setup for determination of beryllium is described in which three SNM-11 crown counters are used. The setup assures necessary sensitivity, high accuracy, and reliability of determinations. (auth)

Neutron

23818 (EUR-1898.e(Add.1)) FIRST ADDENDUM TO THE DATA HANDBOOK FOR SENSITIVITY CALCULATIONS IN NEUTRON ACTIVATION ANALYSIS. Girardi, F.; Guzzi, G.; Pauly, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 28p. Dep.

This addendum covers three analyses by secondary reactions with tritium particles. They can easily be obtained with thermal neutrons and were therefore included. The reaction $^{209}\text{Bi}(n, \gamma)^{210}\text{Bi}$ was also added as analytically significant. Nine sensitivity sheets for short-lived isotopes are included to be substituted for the existing sheets. The sensitivity data were modified to take into account the decay of the isotope during the counting. A counting time of two half-lives was used, instead of the previously adopted ten minutes, for isotopes with half-lives shorter than five minutes, in order to obtain a higher sensitivity. (auth)

42900 THE USE OF $\text{Ge}(\text{Li})$ DETECTORS IN ACTIVATION ANALYSIS. Girardi, F.; Guzzi, G.; Pauly, J. (Joint Nuclear Research Center, Ispra, Italy). *Radiochim. Acta*, 7: 202-9 (Aug. 1967).

Germanium lithium-drifted semiconductor detectors of various dimensions and operating in a "dip-stick" type cryostat were used in activation analysis. The results obtained are presented. Even if the efficiency of the detectors is low, they can be applied in many activation analysis problems with advantages over the scintillator detectors. Techniques for the rapid characterization of the detectors, including evaluation of efficiency and resolution versus gamma energy are described. The flow-sheet of a computer program set up for that purpose is given. (auth)

21897 RADIOCHEMICAL METHODS IN ANALYTICAL CHEMISTRY. II. NEUTRON ACTIVATION ANALYSIS. Bowen, H. J. M. (Univ. of Reading, Eng.). *Chimia (Aarau)*, 21: 113-16 (Mar. 15, 1967).

Activation analysis is a technique of elementary analysis in which samples are exposed to a high flux of neutrons, and the radioactivity induced in selected elements is compared with that produced in known standards. It has the following advantages: wide applicability, sensitivities ranging from 10^{-6} to 10^{-14} g, absence of reagent contamination, built-in checks on reliability, possibility of determining individual isotopes, and reasonable cost. Its disadvantages include: it is only a method of elementary analysis; it needs a source of neutrons; and it is inapplicable to most of the lighter elements which activate to nuclides of short half-life. Current trends in activation analysis include automation of techniques and the development of laboratory neutron sources. Applications are doubling every 3.3 years, notably in the fields of semi-conductor research, metallurgy, geochemistry, cosmochemistry, and inorganic biochemistry. (auth)

25784 USE OF X-RAY SPECTROMETRY IN ACTIVATION ANALYSIS: DETERMINATION OF BROMINE. Shenberg, Cesia; Glat, Jacob; Finston, Harmon L. (Soreq Nuclear Research Centre, Yavne, Israel). *Anal. Chem.*, 39: 780-5 (June 1967).

X-ray counting of ^{80}Br and $^{80\text{m}}\text{Br}$ was applied to the determination of submicrogram amounts of bromine in neutron-irradiated samples containing a large excess of common interfering elements. The precision of the method is about 2%, and an accuracy of 2 to 5% can be attained for Na/Br or K/Br ratios up to 500:1. The method also provides a means of fast analysis of milligram amounts of bromine in organic matter. The advantages of x-ray counting and spectrometry over conventional scintillation gamma spectrometry in nondestructive neutron activation analysis are discussed. (auth)

38917 NONDESTRUCTIVE NEUTRON ACTIVATION ANALYSIS WITHOUT USING GAMMA SPECTROMETRY. Rakovic, Miloslav (Charles Univ., Prague). *Chem. Listy*, 61: 709-17 (June 1967). (In Czech).

A review of the literature (34 references) indicates that, whenever it is feasible, identification of radionuclides formed by activation by physical methods other than gamma spectrometry is less time-consuming and requires less expensive apparatus. The method used most frequently is graphical analysis of the decay curves, by means of which two or three nuclides may be determined provided their half-lives are sufficiently different. Complex decay curves may sometimes be analyzed mathematically. For some elements the high-energy beta may be determined with suitable filters, but the method is not recommended in many cases. A third method is measurement of the predominant activity, which may be used when the other activities are very low. (TTT)

34455 APPARATUS PERMITTING THE UNIFORM RADIO-ACTIVATION OF NONHOMOGENEOUS SAMPLES. Perdijon, J. (SAMES, Grenoble, France). *Nucl. Instrum. Methods*, 53: 335-6 (1967). (In French).

So as to improve the reproducibility of 14 MeV neutron activation analysis, even when the samples are not homogeneous, a device was perfected allowing simultaneous irradiation of the sample and of a standard, while they rotate around the axis of the target and around their respective axis. (auth)

Computer Use

32117 ACTIVATION ANALYSIS WITH THE USE OF THE MATRIX METHOD. Plaksin, I. N.; Starchik, L. P.; Tustanovskii, V. T. *Dokl. Akad. Nauk SSSR*, 172: 104-6 (Jan. 1, 1967). (In Russian).

Programming activation analysis data on the basis of matrices makes it possible to carry out necessary calculations on a computer. The coefficients of the matrix equations may be determined from the measurement of pulses at various photopeak areas. Supplementary measurements increase the reliability of the identification of isotopes present in the specimen and are very useful to resolve questions concerning complex decay schemes. These measurements help establish as many equations as there are unknowns; they are often encountered in the analysis of elements of composite nuclei with varying half lives. Thus, in the determination of rare earths by the (n,2n) reaction with 14 MeV neutrons, the product nuclei may be easily divided in 2 groups with widely differing half lives: $^{155\text{m}}\text{Tb}$, $^{167\text{m}}\text{Er}$, $^{89\text{m}}\text{Y}$, with half lives of the order of seconds, and a second group, ^{140}Pr , $^{143\text{m}}\text{Sm}$, $^{139\text{m}}\text{Ce}$ and $^{141\text{m}}\text{Nd}$, with half lives of the order of minutes. Specific matrix values may also be used for comparing various activation analysis schemes. Standard computer programs may be used to transform the linear algebraic equation systems into equivalent systems with positively determined matrix coefficients. (TTT)

32088 (EUR-3469.e) COMPUTER PROGRAM FOR ACTIVATION ANALYSIS WITH GERMANIUM LITHIUM DRIFTED DETECTORS. Guzzi, G.; Pauly, J.; Girardi, F.; Dorpema, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1967. 40p. Dep.

A computer program, ANGIR, especially developed for activation analysis problems is presented. This program is based on the measurement of photopeak surfaces of complex gamma spectra obtained by means of Ge(Li) detectors. Possible interferences from radioisotopes that give photopeaks that can be superimposed to that measured are evaluated, but not corrected. The program, written in FORTRAN for the IBM 7090, is used routinely for the determination of radioelements in biological specimens. The principles on which the program is based are given, and in appendices the necessary instructions for its use and the complete list are added. (auth)

Biology and Medicine

38898 SIGNIFICANCE OF ACTIVATION ANALYSIS IN MEDICAL SCIENCE. Kertesz, Laszlo (Coll. of Medicine, Debrecen, Hungary). *Kiserletes Orvostudomány*, 18: 627-34 (1966). (In Hungarian).

Activation analysis opens up new possibilities in the field of medical isotope research. A method is described in which the experimental system or a selected aliquot of sample is activated and the isotope formed in it is measured. Experimental results are compared with literature data for I_2 activation, and it is shown that under properly selected experimental conditions, reproducibility, automation, and sensitivity of activation analysis fully satisfy the requirements of a modern medical biological laboratory. 28 references. (JPRS)

40785 FAST-NEUTRON ACTIVATION ANALYSIS OF SILICON IN SPUTUM. Sardi, A. (Central Research Inst. of Physics, Budapest); Tomcsanyi, A. *Analyst*, 92: 529-31 (Aug. 1967).

A method for a relatively rapid and accurate determination of silicon in sputum by activation analysis is described. The method was developed to identify and separate the cases of silicosis from those of pulmonary tuberculosis. The sputum was digested by trypsin, then spun in a centrifuge three times at room temperature, and once after heating with 5% trichloroacetic acid to remove phosphorus, which interferes in the activity measurement. For irradiation, a neutron generator with a fast-neutron yield of 2×10^9 n per cm^2 per second was used. After exposing for 2 to 3 minutes and then waiting for 1 minute the activity measurements are made using a multi-channel analyser for 4 to 6 minutes. The silicon content was evaluated from the aluminium-28 activity produced by the reaction $^{28}\text{Si}(n,p)^{28}\text{Al}$ with a photopeak at 1.78 MeV. The results showed that the silicon content in the sputum of patients suffering from silicosis is, on the average, four times that of the samples used for reference. (auth) (UK)

23832 NEUTRON ACTIVATION ANALYSIS OF POTASSIUM IN BIOLOGIC MATERIAL WITH THE USE OF A NEW SEPARATION METHOD. Rakovic, M.; Prochazkova, Z. (Charles Univ., Prague). *Nucl.-Med.*, 5: 436-40 (1966). (In German).

A new procedure is described for separating potassium-42 in the form of the perchlorate in neutron activation analysis of biological samples. Compared to the classic procedure used in gravimetry (evaporation with HClO_4 to a small volume) precipitation with 20% HClO_4 at room temperature is used. The product thus obtained is radiochemically purer, and the separation is more rapid than in the classic procedure. An optimum of the sodium holdback carrier concentration has been found. The method described has been used to determine potassium in blood samples. (auth)

23848 NEUTRON ACTIVATION ANALYSIS OF METAL TRACE IMPURITIES IN ASCORBIC ACID. Preliminary Communication. Nagy, Lajos György; Mestor, Zoltan; Takacs, Geza. *Magyar Kem. Foly.*, 73: 137-8 (Mar. 1967). (In Hungarian).

Informatory nondestructive and destructive activation analyses of ascorbic acid samples of different origin showed that the samples contained considerable quantities of aluminum, sodium, and in some cases copper, chromium, and antimony as well. (auth)

40798 SOME SPECTS OF THE DETERMINATION OF FLUORINE NEUTRON ACTIVATION AT 14 MeV IN POLLUTED PLANTS. Debiard, Raymond; Fourcy, Andre; Garrec, Jean-Pierre (CEN, Grenoble, France). *Compt. Rend., Ser. D*, 264: 2668-71 (June 5, 1967). (In French).

Determination of fluorine on leaves of apples and grapes sampled in polluted zones was reported. Neutron activation is compared with a chemical method. (tr-auth)

38922 INSTRUMENTAL ACTIVATION ANALYSIS OF VEGETABLE TISSUE. Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). *Talanta*, 14: 753-8 (July 1967).

A nondestructive method for the determination of bromine, manganese, phosphorus, potassium, sodium, and zinc in plant tissue by neutron activation and gamma spectrometry is described. Phosphorus and potassium were determined also by beta-counting. The method should be especially attractive for determination of manganese and zinc. (auth) (UK)

43901 DETERMINATION OF TRACES OF SELENIUM IN BIOLOGICAL TISSUE BY NEUTRON ACTIVATION. Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). *Int. J. Appl. Radiat. Isotop.*, 18: 731-4 (Oct. 1967).

The determination of selenium in biological tissue is discussed. The existence of six stable isotopes of selenium offers several possibilities for activation analysis. A technique based on ^{75}Se is described, with a detection limit of 0.5 nanogram, using a neutron flux of 2×10^{14} n/cm 2 and a sensitive detection system. Details are given of the irradiation procedure, radiochemical separation, and activity measurement. (UK)

38994 ESTIMATION OF THYROID IODINE IN VIVO BY ACTIVATION ANALYSIS. Lenihan, J. M. A. (Western Regional Hospital Board, Glasgow); Comar, D.; Riviere, R.; Kellershohn, C. *Nature (London)*, 214: 1221-3 (June 17, 1967).

Experiments were carried out with sheep, whose thyroid content is of the same order of magnitude as in man. Disadvantages in the use of ^{125}I are discussed. In the studies described ^{125}I was used as an internal standard. On thermal neutron irradiation ^{125}I yields ^{126}I and ^{127}I , the gamma radiations of which occur at several energies between 0.41 and 1.15 MeV. The reactor beam employed was 5 cm dia at the neck of the sheep, and the thermal neutron flux was 3×10^8 n/cm 2 /sec., with a further flux of 3×10^6 at energies about 0.5 eV. Irradiation time was 10 min. The gamma spectra obtained are reproduced, and estimates of thyroid iodine are tabulated. It could be inferred from the results that the iodine (present in organic form in the thyroid) is not dispersed by the circulation, despite the possibility of Szilard-Chalmers reaction. Application of the technique to humans is discussed. (UK)

38344 APPLICATION OF RADIOISOTOPES FOR ANALYSES. V. NEUTRON ACTIVATION ANALYSIS OF AGRICULTURAL SAMPLES. Shibuya, Masao (National Inst. of Agricultural Science, Tokyo). *Nippon Dojo Hiriyogaku Zasshi*, 37: 126-39 (Jan. 1966). (In Japanese).

Neutron activation analysis for determination of ^{55}Mn is described. Only a single grain of rice is needed as a sample. Determination of concentrations of mercury as low as 0.001 ppm in rice samples is also described. Analyses of plant samples for Mn, Cu, Na, Sb, and Zn are discussed. The principles, techniques, advantages and disadvantages of neutron activation analysis are considered. (TSS)

38675 (NP-16798) APPLICATION DE L'ANALYSE PAR RADIOACTIVATION DOSAGE DU MANGANESE DANS LE BLE. (Application of Radioactivation Analysis to Determination of Manganese in Wheat). Soubeyrand, Roland (Grenoble Univ. (France). Faculté des Sciences). July 12, 1965. 35p. (In French). Dep. Thesis.

The radioactivation method was applied to the detection of Mn deficiencies in wheat. The principle of radioactivation determination of Mn in plants was briefly developed. A complete map of the distribution of Mn was established for a mutant wheat and a control wheat. The evolution of the Mn concentration of a wheat cultivated in the laboratory and deprived of this element was followed. (J.S.R.)

Activable Tracers

26861 (EUR-3128.f) ETUDE SUR L'APPLICATION DES TRACEURS ACTIVABLES. (Study of the Application of Tracers). Bondy, C. (Atome Industriel, Chatillon-sous-Bagneux (France)). Sept. 1966. Contract 029-64-7 IRAF. 124p. (In French). DTIE.

A study on activable tracers containing a collection of bibliographical and theoretical data and a report on experiments based on these data is presented. The list of reference works on uses already made of activable tracers is, in principle, complete up to 1 May 1965. A table of theoretical and experimental values on the activation of elements that can be used as tracers enables the searcher to select one or more tracers that may provide the key to his problem. A theoretical review of highly diluted solutions and a number of experiments on the uptake and ageing of tracers provide examples of the tests to be applied to each of the theoretically suitable tracer substances. A bibliographical and theoretical study shows how a liquid phase can be labelled in the presence of its vapour. Examples contribute a mathematical basis from which to predict and interpret each experiment on the true scale. A section on methods of utilizing activable tracers concludes the work. (tr-auth)

Forensic Work

23801 HAIR INDIVIDUALIZATION STUDY BY NEUTRON ACTIVATION. Perkons, Auseklis Karlis. Ontario, Univ. of Toronto, 1965. Thesis.

Neutron radioactivation, instrumental gamma spectroscopy, and digital computer spectrum analysis were used to determine the trace element content and distribution in 947 human hair samples from 780 individual donors for the purpose of hair individualization studies. In the large majority of cases amounts of 20 elements were determined quantitatively, and the probable presence of 5 or 6 others inferred qualitatively from evident gamma energies, specific decay half-lives and, in some instances, radiochemical separation techniques. Results are presented in the form of concentration distribution histograms for each of the components found, including Na and Zn, which are not strictly trace constituents. Further statistical considerations of the data, collected from a large and varied population give rise to the conclusion that individualization of biological materials such as hair is feasible, using the method developed. It was also shown that analysis of a sample of several hairs in the bundle can single out one particular combination of trace element concentrations in a population of from 10^4 to 10^{10} samples, provided enough hair is available, and there is no excessive time lag between the times of collection of the samples to be compared. In addition to the main study of hair individualization, several trends and influences regarding hair thickness and color and the sex, age, dietary, and environmental factors were investigated. It was found that the color of the hair can generally be correlated with the amounts of Mn, Cu, Ni, Co, and Fe present. Gray hair usually shows a higher Ni content; high Fe levels are associated mostly with black, and even more with red hair, dark hair also having higher Mn, Cu, and Co concentrations. The lower amounts of As, Au and Fe, and higher amount of Cu in female hair indicate at least a partial dependence of the concentrations of these elements on sex of the donor. Certain correlations among various members of family groups were also determined. (Diss. Abstr.)

45041 DETERMINATION OF GUNSHOT FIRING DISTANCES AND IDENTIFICATION OF BULLET HOLES BY NEUTRON ACTIVATION ANALYSIS. Krishnan, S. S. (Centre of Forensic Sciences, Toronto). *J. Forensic Sci. Soc.*, 12: 112-22 (Jan. 1967).

A method of identification of bullet holes and determination of gunshot firing distances was developed. A neutron-activation technique for investigation of Sb and Cu around bullet holes produced in different materials by firing various firearms and ammunitions showed that these patterns can be utilized in determining the firing distances with sufficient accuracy, up to distances

much beyond the scope of the existing techniques. The experimental procedure to obtain the concentration patterns of Sb and Cu around bullet holes involved firing test shots on a target material of filter paper or clothing; removal of sections of target material at various distances around the bullet hole (concentric circles of 0.5, 1, 1.5, and 2.0 cm dia); thermal neutron activation of these sections in a reactor at a neutron flux of $\sim 10^{13}$ n/cm 2 /sec for 12 hr; and radiochemical separation of the induced activities of ^{122}Sb and ^{64}Cu in the discharge residues by the method outlined. In some experiments, the neutron-irradiated samples were allowed to decay for a few days before counting. In this way the interfering activities had decayed and only the activity due to ^{122}Sb was seen on the γ scintillation spectrum. This enabled the estimation of Sb without lengthy radiochemical separations. Antimony and Cu patterns could be detected in the target at firing distances of more than 10 ft. In contrast, the conventional techniques such as microscopy, Walker's test, and ir photography do not detect the powder residues beyond a firing distance of 5 ft. (BBB)

21857 (AWRE-O-88/66) THE DETERMINATION OF TRACE ELEMENTS IN HUMAN HAIR BY NEUTRON ACTIVATION AND THE APPLICATION TO FORENSIC SCIENCE. Coleman, R. F.; Cripps, F. H.; Stimson, A.; Scott, H. D. (Atomic Weapons Research Establishment, Aldermaston (England)). Jan. 1967. 37p. Dep. mn. CFSTI \$3.00 cy, \$0.65 mn. HMSO 5s. 6d.

Using neutron activation analysis, the concentration of 12 elements in approximately 750 samples of head hair taken from a representative sample of the population of England and Wales has been determined. About 20 of these samples have been selected for a more detailed study to determine the variation of trace element content in single hairs on the same head. A limited study has also been made of the variation of hair with time and also the variation along the length of a hair. Using a statistical method of combining the data obtained from analysis it is possible to test the similarity of samples of hair and also determine the number of other heads in the population with hair similar to these test samples. This method is illustrated by the examination of ten simulated forensic cases. (auth)

Specific Matrixes

45043 PURITY CONTROL OF URANIUM BY NEUTRON ACTIVATION ASSAY. II. DETERMINATION OF MANGANESE, NICKEL, AND COPPER. Abdel-Rassoul, A. A.; Wahba, S. S. (Atomic Energy Establishment, Cairo). *Talanta*, 14: 1061-7 (Sept. 1967).

Activation analysis applied to the simultaneous determination of manganese, nickel and copper in different uranium samples, including metallic uranium, uranium concentrates, oxide, acetate, nitrate, and sodium uranate. The analytical scheme developed is based on separation of the uranium by paper chromatography and subsequent determination of these elements in the pile-irradiated residues by simple radiochemical operations. The reliability of the scheme proposed was tested, and the limits of sensitivity of the methods worked out are stated. Microgram concentrations of the elements studied could be assayed in limited quantities of the samples analyzed with a precision of $\pm 15\%$. Reagent-blank determinations are also considered. (auth)

32134 AKTIVATSIONNYI ANALIZ GORNYKH POROD I DRUGKH OB'EKTOV. (Activation Analysis of Rocks and Other Objects). Khaidarov, A. A. (ed.). Tashkent, izdatel'stvo Fan Uzbekskoi SSR, 1967. 192p.

Neutron-activation methods for determining various elements in minerals, ores, and deposits are discussed. Applications of the method for gold, copper, bismuth, hafnium, and other elements in ore specimens using scintillation spectra are described as well as the method for determining microelements in ashes of plants and biological tissues. (R.V.J.)

35854 ACTIVATION DETERMINATION OF IMPURITIES IN TRICHLOROMETHYLSILANE WITH EXTRACTIONAL SEPARATION OF THE ELEMENTS. Gilbert, E. N.; Pronin, V. A.; Art-yukhin, P. I.; Nikolaev, A. V. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). *Dokl. Akad. Nauk SSSR*, 172: 853-5 (1967). (In Russian).

A combined extraction-activation method was developed for the removal of impurity elements in trichloromethylsilane. The elements were separated in groups, determining the individual concentrations on the basis of γ spectra without any further separation, except in a few cases when the γ quantum energies of the radioisotopes were too close to each other. The irradiated sample was first dissolved, the gold, antimony, gallium, and iron were separated by solvent extraction. A second group consisting of zinc, cadmium, tungsten, rhenium, silver, platinum, palladium, and iridium, and a third one including indium, copper, tellurium, and tin were then removed separately by varying the solvent used for the extraction agent; this was followed by the removal of cobalt and selenium. Changing the agent, thallium was obtained. The aqueous phase contained potassium, sodium, cesium, arsenic, strontium, barium, chromium, manganese, and nickel, which could then be determined without any further separation, by γ spectrometry. The tests were carried out with rectified trichloromethylsilane. (TTT)

42879 ACTIVATION-ANALYSIS DETERMINATION OF IMPURITIES IN SILICOCHLOROFORM. Rausch, H.; Csada, G. I.; Szabo, E. (Forschungsinstitut fuer Fernmeldewesen, Budapest. Zentralforschungsinstitut fuer Physik, Budapest). *Chem. Zvesti*, 21: 592-601 (1967). (In German).

For determination of the trace impurities Cu, Sb, Cr, Au, As, Hg, and P in trichlorosilane neutron activation analysis, gamma spectrochemical methods, and chemical separation were used. The trace impurities were bound in complexes with triphenylchloromethane, the sample evaporated to dryness, and irradiated in solid form ($1.5 \times 10^{15} \text{ N cm}^{-2} \text{ s}^{-1}$). Since the chlorine content interfered with determination of phosphorus, parallel activation was carried out using a cadmium filter. (tr-auth)

30369 DETERMINATION OF IMPURITIES IN SILICON BY ACTIVATION ANALYSIS. Simkova, M.; Pinkas, V. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). *Isotopenpraxis*, 3: 88-91 (Mar. 1967). (In German).

The content of arsenic, antimony, copper, phosphorus, and zinc in semiconductor-grade silicon was determined by activation analysis. The method consists of two stages: separation of the groups by anion exchange using a mixture of hydrochloric and hydrofluoric acids; and, selective substoichiometric extraction of arsenic and copper by diethyldithiocarbamate, of antimony by cupferron, and of zinc by dithion. Phosphorus was separated extractively in the form of phosphomolybdate. The content of the impurities mentioned above was 10^{-2} to 10^{-3} ppm. The duration of one analysis was about 12 hr. (auth)

35896 NON-DESTRUCTIVE AND DESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF THE IMPURITIES OF SILICON OF SEMICONDUCTOR PURITY. Nagy, L. G. (Polytechnical Univ., Budapest). *Acta Chim. Acad. Sci. Hung.*, 52: 365-74 (1967).

Nondestructive neutron activation analysis of silicon samples of different specific resistivity showed that active gold, sodium, and antimony can be detected in every case, and in some cases iridium and copper are also detectable. By this method a direct relation could be established between the quantity of the impurities and the value of specific resistivity. For determination of copper, gold, and silver, a combined alkaline-acid decomposition procedure was developed, which permits the utilization and the studying of the "scavenging effect" of silica gel prepared within the system. As evident by the results of measurements, these are considerably influenced by the treatment preceding activation (etching and washing), and by the binding of surface impurities before activation. (auth)

42878 DETERMINATION OF SOME TRACE CONTAMINANTS IN HIGH PURITY GALLIUM AND GALLIUM ARSENIDE BY NEUTRON ACTIVATION ANALYSIS. Bujdosó, Ernő; Miskel, Mihály; Ormos, György (Metal Industries Research Inst., Budapest). *Kohasz. Lapok*, No. 5, 236-40 (1967). (In Hungarian).

Determination of the trace contaminants silver, cobalt, iron, indium, and zinc in high-purity gallium and gallium arsenide by activation analysis is reported. Separation of the elements was carried out by extraction, ion-exchange chromatography, and distillation. The method of separation and the results are described. (JPRS)

38911 ACTIVATION DETERMINATION OF IMPURITIES PRESENT IN TUNGSTEN. EXAMPLES OF APPLICATION TO THE LAMP INDUSTRY. Eychemme, M. (Faculté des Sciences, Toulouse); Bayle, Pierre; Blanc, Daniel; Laverlocherre, Jean; Le Strat, Jean. *Chim. Anal. (Paris)*, 49: 355-60 (July 1967). (In French).

After activation of the metal by thermal neutrons, the separations are done by means of ion exchange resins. On each eluate the γ spectrometry and sometimes the β spectrometry after calibration furnish the nature and concentration of each impurity. An activation by 14 MeV neutrons was needed in order to dose oxygen and silicon. The method was applied to the study of the influence of impurities present in tungsten filaments on the functioning of incandescent lamps containing iodine vapor. (auth)

34218 DETERMINATION OF IMPURITIES IN RED PHOSPHORUS BY NEUTRON ACTIVATION AND GAMMA SPECTROSCOPY. PART II. Sorantin, H.; Patek, P. (Reaktorzentrum, Seibersdorf, Austria). *Z. Anal. Chem.*, 229: 255-61 (1967). (In German). (SGAE-CH-41/1966).

Several kinds of commercially available red phosphorus were analyzed by neutron activation and γ spectrometry. The longer living radionuclides were used for determination of the trace elements. Common impurities were antimony, arsenic, cobalt, and chromium, and one sample also contained silver and zinc. (auth)

38887 DETERMINATION OF THE IMPURITIES AND INVESTIGATION ON THEIR DISTRIBUTION IN DIAMOND CRYSTALS OF VARIOUS DEPOSITS USING NEUTRON ACTIVATION ANALYSIS. Glazunov, M. P.; Kodochigov, P. N.; Orlov, Yu. L. (Inst. of Physical Chemistry, Moscow). *Isotopenpraxis*, 3: 231-5 (June 1967). (In Russian).

The impurities in 45 diamonds from various deposits were determined. The following elements were found: Na, Mg, Al, Sc, Ti, Cr, Mn, Co, Cu, La, and Au. For the first time Sc, Co, La, and Au were determined. The distribution of some of the impurities in the bulk of 6 crystals of different shape and coloration was studied. The maximum concentration of the impurities in all the crystals was found to be in a comparatively thin layer near the surface of the crystals. (auth)

30368 QUANTITATIVE ACTIVATION OF THE IMPURITIES IN A CULTURED PEARL. Furuhashi, Nobuyuki; Uemura, Teiji (Industrial Research Inst. of Osaka Prefecture). *Osaka Furitsu Kogyo-Shoreikan Hokoku*, No. 39, 46-9 (July 1966). (In Japanese).

Small amounts of impurities (Mn, Na) in the culture pearls were determined quantitatively by neutron activation. It was found that radiation coloring of pearls is due to inclusion of Mn and not due to Na. Quantitative analysis was achieved by calculations from γ energy peaks for ^{56}Mn (0.845 MeV) and ^{24}Na (1.368 MeV). Concentrations of Mn of over 300 ppm were found in the nucleus of the pearls, while less than 50 ppm were found in a layer and only about 3 to 4 ppm in a golden layer. On the other hand, higher concentrations of Na were found in the layers than in the nucleus. (NSA of Japan)

45052 DETERMINATION OF TRACE ELEMENTS IN CHROMATOGRAPHIC PAPER BY NEUTRON ACTIVATION AND GAMMA SPECTROMETRY. Patek, Peter; Sorantin, Herbert. (Reactor Centre, Seibersdorf, Austria). *Anal. Chem.*, 39: 1458-9 (Oct. 1967).

Whatman chromatographic paper No. 3 (185-200 mg/cm²) was analyzed for trace impurities, their distribution in different charges, and their influence on the degradation and loss of tensile strength during longer irradiations. (J.G.B.)

21893 ACTIVATION ANALYSIS DETERMINATION OF TRACE ELEMENTS IN STONE METEORITES. I. SELENIUM, ARSENIC, ANTIMONY, TIN, MERCURY (CHROMIUM AND COBALT). Kiesel, W. (Univ., Vienna). *Z. Anal. Chem.*, 227: 13-22(1967). (In German).

Trace quantities of selenium, arsenic, antimony, tin, and mercury were isolated from meteorites and minerals after preliminary activation of the samples in a reactor core followed by distillation of the halides from the matrix materials. In the distillate selenium was first precipitated in the presence of strong hydrochloric acid using sulfur dioxide as reducing agent. Further separation was effected on the anion exchanger Dowex 1-X8. On this resin antimony, tin, and mercury were retained while in the effluent arsenic was precipitated as trisulfide and then subjected to measurement. For separation of the adsorbed elements antimony, tin, and mercury two different techniques are discussed. In one case antimony was eluted with aqueous 10% ascorbic acid solution 0.4 N in hydrochloric acid and in the other, which appears to be more advantageous, an aqueous 10% solution of ammonium fluoride 0.5 N in hydrochloric acid was employed. Subsequently in both cases tin and mercury were removed from the resin using 22 N orthophosphoric acid and nitric acid (normality not below 7 N), respectively. The recoveries of this separation method were also determined radiochemically. (auth)

42884 INSTRUMENTAL METHOD OF ACTIVATION DETERMINATION OF MACROCOMPONENT CONTENT IN METEORITES ACCORDING TO SHORT-LIVED ISOTOPES. Chaika, M.; Sabo, E.; Lavrukhina, A. K. (Central Inst. of Physics, Budapest, Inst. of Geochemistry and Analytical Chemistry, Moscow). *Geokhimiya*, No. 9, 1106-16(Sept. 1967). (In Russian).

A series of experiments on the simultaneous determination of the principal components of meteoritic material, such as Mg, Ni, Co, Al, Mn, Fe, and Si have been carried out according to the short-lived radioisotopes being formed in the (n,γ) and (n,p)-reactions correspondingly by irradiation of samples weighing up to 2 mg with reactor neutrons in a Cd-container or without it and by a subsequent nondestructive measurement of the radioisotope gamma radiation on a gamma spectrometer with a 256-channel impulse analyzer. Formulas for calculating the share of reactions with fast neutrons are proposed. Limits of Si, Mg, Fe ratios have been established during their determination. The possibility of utilizing the instrumental activation analysis for the determination of macrocomponents in individual minerals and separate meteoritic chondrules is discussed. (auth)

25801 DISTRIBUTION OF SOME TRACE ELEMENTS IN IRON METEORITES, AS DETERMINED BY NEUTRON ACTIVATION. Smales, A. A.; Mapper, D.; Fouche, K. F. (Atomic Energy Research Establishment, Harwell, Eng.). *Geochim. Cosmochim. Acta*, 31: 873-720(May 1967).

The ten trace elements germanium, arsenic, antimony, copper, chromium, molybdenum, silver, indium, zinc, and palladium were determined in 67 different meteorites, using neutron activation and radiochemical separations. In addition, the meteorites were analyzed for gallium using both neutron activation and colorimetric methods. The sulphur content of 25 of the meteorites was measured, using an evolution and colorimetric method. The meteorites analyzed consisted of a reasonably representative selection of all the structural types of irons. The distribution of the determined trace elements is discussed, in relation to the structural classifications of the iron meteorites. It is shown that a number of meteorites belong to specific structural classes have the same or closely similar trace element composition. Particular attention is paid to the behavior of germanium and gallium, following the widely accepted division of iron meteorites into four distant Ga-Ge "quantized" groups. It is also shown that arsenic, antimony, silver, indium, and zinc are generally concentrated in the coarse and coarsest octahedrite groups, compared with the remaining structural groups. In the case of indium this behavior was observed even at the 0.0005 to 0.01 ppm levels. The distribution of zinc did not appear to be related to that of sulphur. The structural groups are discussed in relation to the evolution of iron meteorites, and to possible correlations with cosmic-ray exposure ages. (auth)

Specific Determinations

30383 DETERMINATION OF HYDROGEN BY NEUTRON ACTIVATION ANALYSIS. Mednis, I. V. (Inst. of Physics, Riga). *Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.*, No. 1, 11-18(1967). (In Russian).

A method was developed for the determination of hydrogen, using a fixed calibration plot. The method was tested on chemically pure substances. The sensitivity limit of the method was 10⁻¹ g of hydrogen. (auth)

25767 (EUR-3161.f(Vol.1)) ETUDE DES POSSIBILITES D'UTILISATION INDUSTRIELLE DE L'ANALYSE PAR ACTIVATION POUR LE DOSAGE DE L'OXYGENE ET EVENTUELLEMENT DE L'AZOTE ET DE L'HYDROGENE DANS LES ACIERS. PREMIERE PARTIE. RAPPORT BIBLIOGRAPHIQUE. (Investigations on the Industrial Application Possibilities of Activation Analysis for the Determination of Oxygen and Eventually of Nitrogen and Hydrogen in Steel. Part I. Bibliographical Report). Stoll, N.; Wagner, A.; Goedert, L. (Acieries Reunies de Burbach-Eich-Dudelange S. A., Luxembourg). Nov. 1966. 48p. (In French). Dep.

Various nonnuclear methods used or being developed for the determination of oxygen, nitrogen, and hydrogen in steel are reviewed. The nuclear reactions that are best suited for the determination of these three elements are considered. The irradiation means suited for use on an industrial scale for the determination of these three elements are discussed and the methods for measuring the induced activity, the methods for neutron flux monitoring, and the sample transfer systems are described. The calibration methods are reviewed and the analytical performances of neutron activation analysis are discussed. It was concluded that among the three elements under consideration solely the oxygen can be determined in steel on an industrial scale by activation. (auth)

25768 (EUR-3161.f(Vol.2)) ETUDE DES POSSIBILITES D'UTILISATION INDUSTRIELLE DE L'ANALYSE PAR ACTIVATION POUR LE DOSAGE DE L'OXYGENE ET EVENTUELLEMENT DE L'AZOTE ET DE L'HYDROGENE DANS LES ACIERS. DEUXIEME PARTIE. DESCRIPTION ET RESULTATS DES ESSAIS. (Investigations on the Industrial Application Possibilities of Activation Analysis for the Determination of Oxygen and Eventually of Nitrogen and Hydrogen in Steel. Part II. Description and Results of the Tests). Stoll, N.; Wagner, A.; Goedert, L. (Acieries Reunies de Burbach-Eich-Dudelange S. A., Luxembourg). Nov. 1966. 69p. (In French). Dep.

Sampling, machining, and selecting the steel samples are discussed. The selection of the analytical methods and of the laboratories retained for the investigations along with the working program followed are described. The apparatus for the determination of oxygen and conditions for carrying out the tests are considered. All the results obtained during the tests are listed. (auth)

25769 (EUR-3161.f(Vol.3)) ETUDE DES POSSIBILITES D'UTILISATION INDUSTRIELLE DE L'ANALYSE PAR ACTIVATION POUR LE DOSAGE DE L'OXYGENE ET EVENTUELLEMENT DE L'AZOTE ET DE L'HYDROGENE DANS LES ACIERS. TROISIEME PARTIE. DISCUSSION DES ESSAIS ET CONCLUSIONS A TIRER DE L'ETUDE. (Investigations on the Industrial Application Possibilities of Activation Analysis for the Determination of Oxygen and Eventually of Nitrogen and Hydrogen in Steel. Part III. Discussion of the Tests and Conclusions to be Deduced From the Investigation). Stoll, N.; Wagner, A.; Goedert, L. (Acieries Reunies de Burbach-Eich-Dudelange S. A., Luxembourg). Nov. 1966. 28p. (In French). Dep.

The analytical results obtained and the advantages and disadvantages of neutron activation and of conventional equipment tested are considered. Installation costs for various neutron activation equipment are indicated and the cost price of one oxygen determination by neutron activation and by conventional means was calculated as a function of the number of determinations performed. It was concluded that neutron activation analysis is capable of determining the oxygen content in steel during productions with rapidity and the accuracy necessary to enable the steel makers to choose the deoxidation means to be added as a function of this oxygen content. (auth)

38910 DIRECT READ-OUT SYSTEM FOR FAST NEUTRON ACTIVATION ANALYSIS FOR OXYGEN IN STEELS. Fujii, I.; Muto, H. (Tokyo Shibaura Electric Co., Ltd.). *Anal. Chim. Acta*, 39: 329-33(Nov. 1967).

Fast-neutron activation is useful for rapid determinations of oxygen in iron and steel, but the conventional calculations are tedious. A direct read-out system is described so that results are immediately available. (auth)

40773 DETERMINATION OF THE OXYGEN CONTENT OF ALUMINIUM BY 14 MeV-NEUTRON RADIOACTIVATION ANALYSIS. Gibbons, D. (Atomic Energy Research Establishment, Wantage, Eng.); Olive, G.; Sevier, P.; Deutschman, J. E. *J. Inst. Metals*, 95: 280-3 (Sept. 1967).

Radioactivation analysis, in which the oxygen is determined through the radioactivity induced by 14-MeV neutron bombardment, was shown to be an acceptable and rapid method for determining oxygen in aluminum and was suitable for routine application. This analytical technique was applied to several industrial problems, including the distribution of oxygen in aluminum remelt, sheet, and extrusion ingots produced by a variety of casting procedures. Furthermore, it should be possible to study the efficacy of metal filtration systems in reducing the oxygen content. The short- and long-term reproducibilities of this method of analysis are acceptable for most purposes and the standard deviation at the 25 ppm oxygen level is <3 ppm. (auth) (UK)

27918 OXYGEN DETERMINATION IN STEEL BY ACTIVATION ANALYSIS. A RAPID NON-DESTRUCTIVE METHOD. Perdljon, J. (Ingenieur Civil des Mines, Grenoble, France). *Atomwirtschaft*, 12: 131-3 (Mar. 1967). (In German).

The oxygen content of steel is an important contaminant that must be determined very rapidly and very accurately. Only activation analysis gives, simultaneously, sufficient rapidity and sensitivity as a nondestructive method. By the introduction of neutron generators it is suitable as an industrial routine method with relatively low cost. Operational experiences and methods were reported on the basis of two years experience with an apparatus specially developed for O_2 determination in steel. (tr-auth)

40782 RAPID ANALYSIS OF BORON IN GLASS BY PROMPT γ -RAY MEASUREMENT. Kusaka, Yuzuru; Tsuji, Haruo; Egawa, Masahiko (Konan Univ., Higashinada, Japan). *Nippon Kagaku Zasshi*, 88: 1006-8 (Sept. 1967). (In Japanese).

Nondestructive determination of boron in glass samples by using an americium-beryllium neutron source (300 mCi) and by measuring the 0.478-MeV prompt γ ray produced in the $^{10}B(n,\alpha)^7Li$ reaction is described. An appropriate arrangement of the neutron source, a paraffin block as a neutron moderator, a lead block as a radiation shield, a lithium fluoride plate as a neutron shield, a sample container, and a prompt γ detector are proposed. The detector was a NaI scintillator (1.5" x 1") connected to a 400 channel pulse height analyzer. This method is applicable for the glass with relatively low boron content (0.5 to 6.0% as B_2O_3). The analytical error was 2 to 4%, and it takes only 15 min for one run. (auth)

40801 DETERMINATION OF PHOSPHORUS IN ROCKS AND MINERALS BY ACTIVATION ANALYSIS. Henderson, P. (Oxford Univ.). *Anal. Chim. Acta*, 39: 512-15 (Dec. 1967).

An initial zirconium phosphate precipitation was carried out prior to irradiation with thermal neutrons. Despite interfering reactions, results proved the method to be accurate with a relative standard deviation of about 2%. The method is not rapid; about 5 days are needed for the analysis of 12 samples with 3 standards, including preparation, counting, and yield determination. (J.G.B.)

40776 URANIUM CONTENT OF CHONDRITES BY THERMAL NEUTRON ACTIVATION AND DELAYED NEUTRON COUNTING. Amiel, Saadia (Soreq Nuclear Research Centre, Yavne, Israel); Gilat, Jacob; Heymann, Dieter. *Geochim. Cosmochim. Acta*, 31: 1499-1503 (Sept. 1967).

Thermal neutron activation followed by delayed neutron counting was applied to the determination of the uranium content of fourteen chondrites. The analysis was performed nondestructively and concentrations in the range of 10 to 30 ppB were measured with a precision of ~10%. (auth) (UK)

42878 RAPID DETERMINATION OF ARSENIC IN COPPER AND BRASS BY NEUTRON-ACTIVATION ANALYSIS. Grimanis, A. P.; Souliotis, A. G. (Democritus Nuclear Research Center, Athens). *Analyst*, 92: 549-52 (Sept. 1967).

A rapid neutron activation analysis method is presented for the determination of microgram amounts of arsenic in copper and brass. Neutron-irradiated samples are dissolved in hot perchloric acid in the presence of an arsenic carrier. The resulting solution is made 7.4M with respect to perchloric acid and 1.2M with respect to hydrobromic acid. The arsenic-76 and the arsenic carrier are extracted quantitatively into benzene. After washing the benzene layer with 7.4M perchloric acid-1.2M hydrobromic acid mixture, arsenic-76 is counted directly in the organic phase. The radiochemical purity of the arsenic-76 extract was demonstrated by using a multichannel analyser, together with decay studies. After irradiation the time required to complete the analysis is less than 15 minutes, which is at least four times shorter than that previously reported for activation analysis methods. The proposed method was successfully applied to the determination of arsenic in copper and brass primer cups and primer pockets (arsenic content 1 to 50 ppm). (auth) (UK)

23814 (CEA-R-3100) ANALYSE PAR ACTIVATION DE L'ARGON: APPLICATION A LA DATATION PAR LA METHODE POTASSIUM-ARGON. (Argon Activation Analysis: Application to Dating by the Potassium-Argon Method). Dumesnil, Patrice (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 70p. (In French). Dep.

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

Activation analysis using ^{40}Ar was applied to rock-dating by the K-Ar method. Argon is extracted from the sample, purified, activated to saturation in a flux of 2×10^{13} neutrons/cm²/sec⁻¹, and measured by gamma spectroscopy. The sensitivity obtained is such that it is possible to measure amounts of argon corresponding to an age of a few thousand years only. However, since it was not possible to measure the amount of pollution of radiogenic argon by atmospheric argon with any accuracy, the measurable age limit is of the order of millions of years. The method was applied to basalts from the Mont-Dore region. The results obtained are in fairly good agreement with geological, stratigraphic, and paleomagnetic data. (auth)

23850 USE OF NUCLEAR (n, γ) REACTION IN DETERMINING CADMIUM CONTENT. Plaksin, I. N.; Malysheva, N. G.; Starchik, L. P. (Inst. of Mining, Moscow). *Dokl. Akad. Nauk SSSR*, 171: 393-4 (Nov. 11, 1966). (In Russian).

Since Cd has a high capture cross section of 2550 barns, it can readily be determined in ores and solutions by neutron irradiation. A Po-Be source with a paraffin moderator and with 150 μ Ci of activity is used to generate the thermal neutrons. A NaI(Tl) detector is used to count the gamma photons from the induced Cd activity. The Cd content of Cu-Zn concentrates is shown to be a linear function of the count rate. The sensitivity of the method is 0.035%, and the relative error is 3 to 4% for a 1% Cd content. (TTT)

42883 THE DETERMINATION OF COPPER AND BISMUTH IN HIGH-PURITY LEAD METAL BY NEUTRON ACTIVATION ANALYSIS. Op De Beeck, J.; Hoste, J. (Ghent Univ.). *Acta Chim. Acad. Sci. Hung.*, 53: 137-43 (1967).

The determination of copper and bismuth in lead in the presence of Hg, Au, Sb, Cd, and Tl impurities requires destructive separation following neutron activation. The internal electrolysis technique was shown to be the most suitable method for this purpose. (auth)

40794 NEUTRON ACTIVATION ANALYSIS OF Co, Zn, Cr, Sc, AND NI TRACES IN ALFIANELLO AND ALBARETO METEORITES. Breccia, Alberto; Dellonte, Sergio; Nucifora, Giuseppina (Univ., Bologna, CNR, Bologna). *Ric. Sci.*, 37: 319-22 (Apr. 1967). (In Italian).

Data on the neutron activation analysis of Co, Zn, Cr, Sc, and Ni traces in Alfianello and Albareto meteorites are presented. The separation of the radionuclides was carried out by ion exchange chromatography. The Albareto samples contained a greater amount of Zn and a smaller amount of Sc than the Alfianello samples. The different contents of these elements suggest that they are related to two different kinds of meteorites. (auth)

40790 NEUTRON ACTIVATION OF TRACES IN ELECTROLYTIC ZINC SULPHATE SOLUTIONS. PART I. SIMULTANEOUS DETERMINATION OF MERCURY, URANIUM, AND YTTERBIUM. Dams, R.; Hoste, J. (Ghent Univ.). *Anal. Chim. Acta*, 39: 423-32 (Dec. 1967).

A neutron activation determination of traces of mercury, uranium, and ytterbium in electrolytic zinc sulfate solutions was devised. The isotope ^{197}Hg was measured by means of its 68- and 77-keV photopeaks. Uranium was determined by measurement of the 106-keV photopeak of the ^{235}Np daughter activity. The 50- and 53-keV γ rays of ytterbium isotopes ^{169}Yb and ^{175}Yb were counted using a 1-mm thick NaI(Tl) water crystal. The chemical separation was performed on anion exchange resin. The matrix activities were eliminated in 1.85 N hydrofluoric acid while the neptunium and ytterbium activities were desorbed with 5 N hydrochloric acid. Mercury was eluted from the column with 0.5 M thiourea-0.005 N hydrochloric acid and precipitated as sulfide. (auth)

25796 DETERMINATION OF TRACE AMOUNTS OF MAGNESIUM, STRONTIUM, AND NICKEL IN LAKE-WATER SAMPLES BY NEUTRON-ACTIVATION ANALYSIS. Souliotis, A. G.; Belkas, E. P.; Grimanis, A. P. (Nuclear Research Center Democritus, Athens). *Analyst*, 92: 300-4 (May 1967).

Neutron activation analysis was used to determine magnesium, strontium, and nickel in water from eleven Greek lakes. The elements were separated by an isolation procedure (taking up to 30 minutes); the magnesium and strontium were determined by γ -spectrometry, and the nickel by β -coincidence counting. The ranges found were 11 to 31 ppm of magnesium, 0.02 to 1.12 ppm of nickel, and 0.07 to 0.48 ppm of strontium. (auth)

32121 DETERMINATION OF PALLADIUM, OSMIUM, IRI-
DIUM, AND PLATINUM IN ROCKS BY NEUTRON-ACTIVATION
ANALYSIS. Maleszewska, Hanna (Inst. of Nuclear Research,
Warsaw). Chem. Anal. (Warsaw), 12: 281-91(1967). (In Polish).

A method is described for the determination of microquantities of palladium, osmium, platinum, and iridium in rocks. The samples were irradiated in a thermal neutron flux of 3.6×10^{11} neutrons/cm²/sec in the EWA reactor for 20 hr. Radiochemical separation using carriers was carried out in order to isolate the activities induced. Palladium, platinum, and iridium were separated from samples by precipitation and extraction. Palladium was finally isolated as dimethylglyoximate and platinum and iridium as free metals. Osmium was separated from the samples by distillation of its volatile tetroxide, which was subsequently absorbed in 6N hydrochloric acid saturated with sulfur dioxide. The sensitivity of the method for palladium was 10^{-7} g, for osmium was 10^{-8} g, for iridium was 10^{-7} g, and for platinum was 5×10^{-8} g. (auth)

42876 ACTIVATION ANALYSIS OF POTASSIUM AND
SODIUM, AND THEIR BEHAVIOUR ON CATION EXCHANGE
RESIN. Baptista, J. L.; Grade, M. R. S. (Comissao de Estudos
de Energia Nuclear, Lisbon). pp 424-8 of The Alkali Metals.
London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19-22, 1966. See CONF-660712.

Experiments are described for the determination of small quantities of Na and K by radioactivation, followed by the use of a weak ion exchange resin in the carboxylic acid form for separation purposes. Samples of 0.1 mg of solid Na and K oxalates were irradiated in a thermal neutron flux of 10^{12} /cm²/sec. Cylindrical resin beds of Amberlite IRC-50 in polyethylene columns were used for the separation. Electronic equipment continuously measured the radioactivity from the columns. Samples passed through the columns were prepared by mixing amounts of Na and K in proportions 4:1 and 2:1 respectively in the range 10^{-5} g. For each experiment a pair of columns was used under similar conditions, only distinguished by the use of ^{42}K or ^{24}Na as tracer. On elution with HCl (pH 2.18 to 2.50) there was rapid isolation of alkali metals by a small volume of eluant, but a high hydrogen affinity to the weak group of the resin caused Na and K to elute very quickly. Oxalic acid eluant gave similar results to those with HCl of pH 2.18. With acetic acid (0.13 to 0.06M) there was a slight displacement of the K peak in relation to that of Na, and after a few minutes Na was obtained free of K. With ammonium oxalate peaks were narrower than with the other solutions, and some separation occurred at pH 9.5. (UK)

35884 DETERMINATION OF POTASSIUM IN RUBIDIUM AND
CESIUM SALTS BY ACTIVATION ANALYSIS. Bastian, J.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 7: 152-3(June 1967). (In German).

After neutron activation potassium was separated quantitatively from rubidium and cesium by using columns filled with titanium hexacyanoferrate(II). It was precipitated as potassium tetraphenylborate. (auth)

30377 NEUTRON ACTIVATION ANALYSIS FOR SODIUM
TRACES IN MAGNESIUM. Malvano, R. (SORIN, Salsuggia-
Vercelli, Italy). Anal. Chim. Acta, 38: 341-7(July 1967).

When sodium traces are determined in magnesium matrices by neutron activation analysis, the reaction $^{24}\text{Mg}(n,p)^{24}\text{Na}$ interferes by simulating spurious sodium concentrations (about 400 to 500 ppm for usual irradiation positions in the RS 1 water-pool reactor). A preliminary separation of the sodium traces from the bulk of the matrix by electrodeposition on a mercury cathode and recovery in water by amalgam decomposition prevented the fast-neutron effects. Electrolysis for 4 hr gave almost quantitative recovery of sodium ($93 \pm 5\%$) and satisfactory decontamination factors for magnesium (1.5 to 5.10^3). The method is limited by the blank correction ($14 \mu\text{g Na}$ with a glass electrolysis cell). Some results for magnesium samples with both destructive and nondestructive techniques are reported. (auth)

35835 (BARC-280) USE OF REACTOR FAST NEUTRONS IN
THE ANALYSIS OF FLUORINE. Reddy, G. R.; Sankar Das, M. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 10p.

Utilization of fast neutrons for the activation-analysis determination of fluorine by the $^{19}\text{F}(n,2n)^{18}\text{F}$ reaction is described. The average cross section for this reaction in a spectrum of fission neutrons was determined using $^{58}\text{Ni}(n,p)^{58}\text{Co}$ as a monitor for flux measurements. Application of the reaction was demonstrated by analyzing teflon samples for their fluorine content. The practical sensitivity of the method is $500 \mu\text{g}$ of fluorine under the experimental conditions. (auth)

27923 DETERMINATION BY INSTRUMENTAL ACTIVATION
ANALYSIS OF TRACES OF CHLORINE IN ORGANIC SUB-
STANCES WITH NUCLEAR APPLICATION. Orvini, E. (Univ.,
Pavia, Italy). Energ. Nucl. (Milan), 14: 249-51(Apr. 1967). (In French).

The determination by instrumental neutron activation analysis of chlorine impurities was applied to organic materials such as polyethylene, delrin, polystyrene, nylon, and terphenyl. The sensitivity of the method of determination is about 0.05 ppm. The precision is in the range ± 3 to $\pm 10\%$ for chlorine contents in the range of 0.05 to several ppm. (tr-auth)

32127 DETERMINATION OF CHLORINE IN U. S. GEOLOG-
ICAL SURVEY STANDARD ROCKS BY NEUTRON ACTIVATION
ANALYSIS. Johansen, O.; Steinnes, E. (Institut for Atomenergi, Kjeller, Norway). Geochim. Cosmochim. Acta, 31: 1107-9(June 1967).

The chlorine content in eight U. S. Geological Survey standard rocks was determined by neutron activation analysis. The results are within the range 9.4 to 431 ppm, and the precision from duplicate determinations is about $\pm 3\%$. (auth)

37606 DETERMINATION OF CHROMIUM DISTRIBUTION
IN LASER RUBIES WITH NEUTRON ACTIVATION. Pink, H. (Siemens Aktiengesellschaft, Munich). Phys. Status Solidi, 21: K111-13(June 1, 1967).

Sections of a polished ruby single crystal were irradiated with thermal neutrons for 14 days. Two hundred hours after the end of irradiation, the sections were exposed to photoplates, when they were then developed in the usual manner. Zones of higher and lower chromium concentration were indicated by light and dark sections on the resulting figures. (A.G.W.)

34232 DETERMINATION OF TRACES OF IRIDIUM IN RHO-
DIUM BY NEUTRON ACTIVATION ANALYSIS. Gijbels, R.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 39: 89-93(Sept. 1967).

Iridium traces were determined in rhodium by thermal neutron activation for 2 days at a flux of 4×10^{11} n/cm²/sec. After cooling for at least 1 week, the samples were analyzed by γ spectrometry. No radiochemical separations were required. Special attention was paid to self-absorption phenomena in the rhodium samples. (auth)

27907 ACTIVATION ANALYSIS OF TUNGSTEN AND AR-
SENIC IN V_2O_5 BY COINCIDENCE SPECTROMETRY. Adams, F.; Hoste, J. (Ghent Univ.). Acta Chim. Acad. Sci. Hung., 52: 115-22(1967).

The 0.550-MeV gamma radiation of ^{76}As interferes with the non-destructive direct spectrometric determination of the W and As content of purified vanadium pentoxide. To eliminate this difficulty, a method was developed for determination of the elements in the presence of each other by gamma-gamma coincidence techniques. The determination of ^{187}W is rendered possible by measurement of the 134 KeV and 72 KeV cascade photons, and that of ^{76}As by the measurement of the 0.55 and 0.65 MeV cascade gamma photons. (auth)

34221 DETERMINING LITHIUM BY MEANS OF THE REAC-
TIONS $^6\text{Li}(n,\alpha)^3\text{H}$ AND $^{10}\text{B}(t,n)^{10}\text{F}$. Dutov, A. G.; Lobanov, E. M.; Leushkina, G. V.; Matveeva, N. P. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 76-8(1966). (In Russian).

An aqueous LiF solution along with a standard LiF solution ($150 \text{ mg per } 100 \text{ ml H}_2\text{O}$) was irradiated at a neutron flux of $1 \times 10^{12} \text{ sec}^{-1} \text{ cm}^{-2}$ for a period of 30 minutes. The ^{18}F activity with a half-life of 112 min was formed by the $^6\text{Li}(n,\alpha)^3\text{H}$, $^{10}\text{B}(t,n)^{10}\text{F}$ sequence of reactions. Tritons from the ^6Li spallation reacted with ^{10}B in the water to give ^{18}F ($T_{1/2} = 112 \text{ min}$). Because of the high background of activities due to impurities in the samples, it was necessary to carry the ^{18}F on a $\text{Ca}(\text{OH})_2$ precipitate at a pH of 7.0. About 80% of the ^{18}F activity was carried by the $\text{Ca}(\text{OH})_2$ precipitate. The 0.51 MeV annihilation peak of ^{18}F was counted. The average error of the analysis was 15 to 19%. The minimum amount of Li which can be determined by this method was $2 \times 10^{-4} \text{ g}$ on irradiation in a neutron flux of $10^{13} \text{ sec}^{-1} \text{ cm}^{-2}$. Ten samples could be analyzed in a period of 2 to 3 hr. (TTT)

32100 RADIOACTIVE DETERMINATION OF TANTALUM
IN A HIGH PURITY NIOBIUM PENTOXIDE. Alimarin, I. P.; Bilimovich, G. N.; Yakovlev, Yu. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zavod. Lab., 33: 672-6(1967). (In Russian).

A direct γ -spectrometric method was developed for determining up to $1 \times 10^{-4}\%$ Ta in Nb_2O_5 . A radiochemical separation of smaller amounts from irradiated specimens is described. Extraction of $(\text{C}_6\text{H}_5)_4\text{AsTaF}_6$ by chloroform achieved the sensitivity of $1 \times 60^{-6}\%$. (R.V.J.)

34233 NEUTRON ACTIVATION ANALYSIS FOR GOLD IN OSMIUM. Gijbels, R.; Hoste, J. (Ghent Univ.). *Anal. Chim. Acta*, 39: 132-5 (Sept. 1967).

Methods for determining gold in osmium by neutron activation with and without chemical separation are described. After Os and Ru are distilled from boiling bromate-sulfuric acid mixture the gold remaining in the residue can be determined by γ -spectrometric analysis without further chemical separation, for its γ -energy (411 KeV) differs sufficiently for that of $^{192(194)}\text{Ir}$. If chemical separation is desired, gold can be easily extracted with ethyl acetate from HCl medium. Using 2N HCl and thorough washing of the organic phase, 99 to 99.5% of the ^{198}Au was recovered. Gold can be determined in the presence of a 25-fold amount of iridium without chemical separation. After chemical separation the ratio can be increased to 100. (D.H.M.)

38896 INTERFERENCE FROM NATURAL RADIOACTIVITY IN NEUTRON ACTIVATION ANALYSIS FOR BISMUTH IN LEAD. De Boeck, R.; Adams, F.; Hoste, J. (Ghent Univ.). *Anal. Chim. Acta*, 39: 270-2 (Oct. 1967).

Naturally occurring ^{210}Bi can interfere with the ^{210}Bi formed by neutron activation from the $^{209}\text{Bi}(n,\gamma)^{210}\text{Bi}$ reaction. This isotope is present in variable concentration in recently fabricated lead as a result of the occurrence of uranium in lead ores. Through the manufacturing process, the series is interrupted at ^{210}Pb so that the ^{210}Bi activity decays with the half-life of ^{210}Pb , namely 21 years. The natural radioactivity of ^{210}Po was determined in lead so that the error in activation analysis for bismuth could be estimated. It appears that the disintegration ratios of ^{210}Po and ^{210}Bi are approximately the same. The sensitivity of activation analysis of bismuth through measurement of ^{210}Po can be increased by separating the bismuth from the lead after irradiation followed a separation of the ^{210}Po daughter ingrown from the total ^{210}Bi activity. Interference can also be minimized by increasing the neutron flux. (D.H.M.)

38889 APPLICATION OF VARIOUS METHODS IN ACTIVATION ANALYSIS FOR IRON AND COBALT. Bondy, Charles (Atome Industriel, Grenoble, France). *Anal. Chim. Acta*, 38: 579-80 (Aug. 1967). (In French).

The method used for activation analysis of Fe and Co solutions of unknown concentrations, provided by the Commission for Establishment of Methods of Analysis of the French Atomic Energy Commission, are briefly described and the results obtained by the various methods compared. (J.S.R.)

27922 ANALYSIS OF NUCLEIC ACID CONTENT OF TETRAHYMENA BY MEANS OF INDUCED RADIOACTIVITY. Akaboshi, Mitsuhiro; Waki, Asako (Kyoto Univ.). *Dobutsugaku Zasshi*, 75: 183-6 (June 1966). (In Japanese).

Commercially available salmon sperm DNA was activated by exposure to a neutron flux of approximately 4×10^{12} n/cm²/sec for an hour at the pneumatic tube of the reactor of Kyoto University. Immediately after activation, samples emitted β and γ rays, due to ^{32}P and ^{24}Na , respectively, but after 7 days' cooling, only β rays from ^{32}P were detectable. The counts of β rays then gave the amount of DNA-P. Sensitivity of this method under the conditions described above was found to be 0.5 μg DNA. Contents of DNA and RNA in *Tetrahymena pyriformis* W. were determined by this method. They were 2.77 to 3.44×10^{-6} μg P/cell and 41.9 to 47.8×10^{-6} μg P/cell, respectively. In this case, DNA was separated by DNase from nucleoprotein and residual proteins were removed by precipitation with formic acid. To improve the sensitivity of this activation analysis of nucleic acids in the living cell, it is necessary to minimize the loss of nucleic acids or cells from the small amounts of samples in the process of extraction. (NSA of Japan)

25807 A TRIAL METHOD OF DETERMINING URANIUM AND THORIUM CONTENT OF ROCKS IN RADIOACTIVE DISEQUILIBRIUM BY NEUTRON ACTIVATION ANALYSIS. I. Hatada, Zin'itiro (Kyoto Univ.); Nishimura, Susumu; Asayama, Tetsuji (Mem. Coll. Sci., Univ. Kyoto, Ser. B, 33: 47-51 (Nov. 1966)).

Procedures are described for determining the U and Th content of some basic lavas by the neutron activation method. The rock samples are first activated by bombardment and then subjected to spectrometry after an optimum period of cooling, during which most of the induced short-lived nuclides have decayed. These lavas revealed radioactive disequilibrium by α and γ spectra interpretation. The U content of some lavas of younger ages was found to be smaller than that calculated from their Ra content assuming radioactive equilibrium, while their Th/U ratios were of average value for such rocks. The Th/U ratio ranged from 2.33 to 3.72 with an average of 3.11, which is a reasonable value for basic lavas. The Ra content of these lavas was excessive because the time elapsed since their eruption was shorter than that required for attaining radioactive equilibrium between U and Ra. (BBB)

45039 A TRIAL METHOD OF DETERMINING URANIUM AND THORIUM CONTENT OF ROCKS IN RADIOACTIVE DISEQUILIBRIUM BY NEUTRON ACTIVATION ANALYSIS. 2. Hatada, Zin'itiro; Nishimura, Susumu; Asayama, Tetsuji (Kyoto Univ.). *Mem. Coll. Sci. Univ. Kyoto, Ser. B*, 33: 221-6 (Mar. 1967).

Newly obtained U and Th contents of some basic lavas from various localities are reported, and as a reference, Ra content of lavas hitherto obtained by other authors are summarized. The samples were mostly of lavas from islands in the Pacific Ocean. U and Th contents were determined by neutron activation analysis. The Th/U ratios ranged from 2.3 to 3.7 for lavas from Sakurajima, Kirishima, and Aso volcanoes in the Kyusyu district, and those from Hakone and Asama volcanoes, while most of the lavas from the islands, (Izu-Oshima, Miyakejima, and Hawaii) showed higher Th/U ratios (3.8 to 5.8). Considering that the former group of lavas are andesite and the latter basalt, this tendency nearly corresponds to earlier findings that the average ratios for intermediate and basic rocks are 2.6 and 4.0, respectively. For the igneous rocks younger than 10^8 yr, it was considered that the content of Ra is less than the equilibrium amount relative to U, as the Ra/U ratio in equilibrium is about 3.5×10^{-7} . Andesite lavas from the Kyusyu district and most of the basaltic lavas of Hawaii unexpectedly revealed excessive contents of Ra. Assuming that the Ra determination was correct, the possibility arises that the Ra content of tholeiite lavas will be normal with respect to U content, while that of alkali olivine basalt lavas highly excessive. (BBB)

27909 ORE ANALYSIS FOR THORIUM AND URANIUM BY DELAYED NEUTRONS. Lee, N. K.; Lin, S. C.; Chien, J. P.; Lee, Y. H. (National Tsing Hua Univ., Hsinchu, Taiwan). *Ho Tsu K'o Hsueh*, 5: No. 1-2, 23-8 (Dec. 1966).

The method of delayed neutrons was employed for determination of thorium and uranium in local ores. The pneumatic tube of THOR was used for irradiation. Cadmium ratios of thorium and uranium were measured by standard samples. Thorium and uranium contents in unknown samples were evaluated from the counts of delayed neutrons with and without cadmium covers during irradiation. The experimental time required for each sample was about 2 1/2 min. The results agreed well with those obtained by the gamma spectrometry. (auth)

30357 DETERMINATION OF THE VANADIUM CONTENT IN PETROLEUMS PROCESSED IN HUNGARY BY MEANS OF ACTIVATION ANALYSIS. Vajta, Laszlo; Palmay, Gyorgy; Szebenyi, Imre; Toth, Geza (Technical Univ., Budapest). *Period. Polytech. Chem. Eng.*, 10: 269-78 (1966). (In German).

Crude oil samples were analyzed for vanadium content by means of activation analysis. The samples were encased in Cellothen foil (commercial polyethylene-cellophane combination) and irradiated in a Hungarian research reactor (flux $\sim 5 \times 10^{12}$ n/sec sq cm) for 10 seconds. The γ spectrum of the activated samples was obtained in the KFKI 128-channel analyzer. The vanadium content was determined on the basis of the 1.44-MeV photopeak of ^{52}V . The techniques and the dependability of the method are described. The vanadium losses of the samples ranged between 0.5 and 8.8% of the total. (JPRS) *same as 45033*

32119 DETERMINATION OF HAFNIUM CONCENTRATION IN ZIRCONIUM. I. Onosov, A. I.; Perovskii, A. P. *Radio-khimiya*, 9: 269-71 (1967). (In Russian).

32118 DETERMINATION OF HAFNIUM CONCENTRATION IN ZIRCONIUM. II. Onosov, A. I.; Perovskii, A. P. *Radio-khimiya*, 9: 271-3 (1967). (In Russian).

A neutron activation method for determination of the concentration of hafnium in binary mixtures of Zr-Hf is described, during which the different lifetimes of the intermediate states of ^{95}Zr and ^{181}Hf are used. In comparison with the previous method this method gives an increase in precision, especially in the area of low hafnium concentrations. (tr-auth)

45035 DETERMINATION OF TRACES OF URANIUM IN ROCKS AND MINERALS BY NEUTRON ACTIVATION. Turkowsky, C.; Staerk, H.; Born, H. J. (Technische Hochschule, Munich). *Radiochim. Acta*, 8: 27-30 (Sept. 1967). (In German).

A neutron-activation method was worked out for determination of traces of uranium in geological materials. The nuclide chosen is ^{235}U . Samples were irradiated for 60 min in a cadmium capsule at a resonance neutron flux $\phi_{\text{res}} = 1.3 \cdot 10^{11}/\text{cm}^2$ sec using a pneumatic tube system of the FRM München. Fast radiochemical separations in the presence of carrier uranium gave ^{239}U in a radiochemically pure form. Activity measurements were taken on a β -proportional counter nearly 50 min after irradiation. The method described has a sensitivity of 0.005 μg U/100 mg sample with an accuracy of about $\pm 5\%$. (auth)

34278 NEUTRON ACTIVATION METHOD FOR MEASURING THE WEAR OF ELECTRIC TRAIN GEAR WHEELS. Pelekis, Z. E.; Pelekis, L. L.; Smirnov, V. I.; Taure, I. Ya. (Inst. of Physics, Riga). *Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.*, No. 2, 121-6 (1967). (In Russian).

A neutron activation method for determining the wear of electric

train gear wheels was developed and verified in working conditions. The weight of the wear particles in the lubricant is determined after the irradiation in an atomic reactor of ^{56}Mn from the γ -spectrum. The sensitivity of the method has been found to be 0.1 mg steel in 1g liquid lubricant. (auth)

42887 THE MEASUREMENTS OF EROSION OF CONDENSER TUBE BY NEUTRON ACTIVATION ANALYSIS. 2. Kawai, Keiji (Marine Tech. Coll., Hyogo, Japan). Nippon Kokai Gakkai Shi, No. 35, 51-56 (July 1966). (In Japanese).

Some quantities of Mn in seawater were measured by neutron activation analysis in order to estimate the erosion of condenser tubes of steam engines. The samples, seawater with added MnCl_2 , absorbed on a piece of filter paper, were bombarded in thermal neutron flux of 4×10^{12} n/cm²·sec for 20 min. After bombardment, the Mn was chemically separated from ^{24}Na and ^{38}Cl and the activities of ^{56}Mn were measured using a RCL-256 channel pulse-height analyzer. Mn in seawater could be determined up to 0.00005 mg in 1 cc of seawater. (NSA of Japan)

Separations

45062 DETERMINATION OF MICROIMPURITIES IN GALLIUM ARSENIDE BY A RADIO-ACTIVATION METHOD. Giltbert, E. N.; Artyukhin, P. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 4, 90-4 (Mar. 1967). (In Russian).

A method for estimation (by activation methods) of Au, Ta, Sc, Hf, Zr, K, Na, Ca, Sr, Ba, Mn, Ni, Cr, and rare earths in gallium arsenide, involving extraction separation of elements into groups suitable for γ spectrometric determination is reported. β , β' -Dichlorodiethyl ether, dimethylbenzylalkylammonium chloride, di-n-butylthiophosphoric acid and α -n-nonylpyridine-N-oxide were used as extractants. (auth)

30374 NEUTRON ACTIVATION ANALYSIS BY STANDARD ADDITION AND SOLVENT EXTRACTION. DETERMINATION OF TRACES OF THORIUM IN ALUMINIUM BY EXTRACTION OF ^{233}Pa . Allan, A.; Sanad, W. (Atomic Energy Establishment, Cairo). Anal. Chim. Acta, 38: 327-32 (July 1967).

A rapid and selective radiochemical separation for protactinium-233 is suggested. The method is based on extraction of protactinium with 0.3 M tridodecylamine from 4.5 M HCl-1.5 M AlCl_3 solution, stripping with 1.35 M HCl followed by another extraction with 0.5 M 2-thenoyltrifluoroacetone. The separation, coupled with the application of the standard addition technique, is applied to the determination of traces of thorium in aluminum by neutron activation. (auth)

45044 NEUTRON ACTIVATION ANALYSIS BY STANDARD ADDITION AND SOLVENT EXTRACTION. DETERMINATION OF IMPURITIES IN ALUMINIUM. Allan, A.; Haggag, A. (Atomic Energy Establishment, Inshas, United Arab Republic). Talanta, 14: 1109-19 (Sept. 1967).

A separation scheme based on selective extraction in conjunction with the standard addition technique was developed for the determination of impurities in aluminum by neutron activation. Preliminary investigations were carried out on the extractability of Sc, Co, Hf, Fe, Sn, Cd, Zn, Ag, Cr, Ce, Cs, and Rb by TDA (tri-n-dodecylamine) and TBP (tributyl phosphate) from acidic media. The best conditions are predicted for the separation of these elements into fractions suitable for analysis by γ spectrometry. Recovery values of ~90% were obtained for all the elements. (auth) (UK)

45065 NEUTRON-ACTIVATION ANALYSIS BY STANDARD ADDITION AND SOLVENT EXTRACTION. DETERMINATION OF SOME TRACE ELEMENTS IN GRANITE AND DIABASE ROCKS. Allan, A.; Shabana, R. (Atomic Energy Establishment, Cairo). Microchem. J., 12: 427-33 (Sept. 1967).

A rapid procedure is presented for the determination of Sc, Th, Co, Fe, Ag, Zn, and Hg in granite and diabase rocks by neutron-activation analysis. The induced ^{233}Pa , ^{60}Co , ^{59}Fe , ^{110}Ag , ^{66}Zn , and ^{203}Hg are extracted with TDA, while ^{46}Sc is then separated with TBP. The extracted isotopes are sequentially eluted from the TDA extracts with various acidic solutions; ^{233}Pa and ^{60}Co contained in one of the fractions are subsequently separated by the selective extraction of ^{233}Pa with TTA. The presented method gives satisfactory accuracy and precision. (auth)

39020 RADIOCHEMICAL SEPARATIONS USING THE RING OVEN METHOD. II. THE SYSTEM $^{99}\text{Mo}/^{99\text{m}}\text{Tc}$. Klockow, D. (Univ., Freiburg i. B.). Talanta, 14: 817-21 (July 1967). (In German).

The separation of ^{99}Mo and $^{99\text{m}}\text{Tc}$ by the ring-oven technique is described. The separation is best carried out on round papers impregnated with Prussian Blue or with manganese dioxide, when the molybdenum is fixed in the center of the paper and the technetium is concentrated with 70 to 90% yield in the ring. Decontamination factors of $\geq 10^3$ were obtained. $^{99\text{m}}\text{Tc}$ formed after the separation can be further leached from the parent nuclide. The half-life of $^{99\text{m}}\text{Tc}$ was found to be 6.06 ± 0.05 hr. (auth) (UK)

38919 APPLICATION OF REVERSED-PHASE COLUMN CHROMATOGRAPHY TO THE DETERMINATION OF TUNGSTEN IN STAINLESS STEELS BY ACTIVATION ANALYSIS. Espanol, Carlos E.; Marafuschi, Ana Maria (Univ., Buenos Aires). J. Chromatogr., 29: 311-15 (July 1967).

Reversed-phase partition chromatography was used after irradiation to isolate tungsten from unwanted major components of steel. Polytrifluoroethoxyethylene (Kel-F) was used as an inert support for tri-n-octylamine (TNOA). The anionic metal complexes were retained on the top of the chromatographic column while the element which did not form anionic complexes were quickly eluted. Results from the analysis of various stainless steel samples show that the Kel-F-TNOA columns were suitable for the isolation and determination of tungsten, and subsequently cobalt in stainless steels. The time required for the method was about three hours including irradiation time. (D.H.M.)

40779 CHROMATOGRAPHIC SEPARATION OF CARRIER-FREE ^{90}Sr AND ^{90}Y ON PAPER IMPREGNATED WITH STANNIC PHOSPHATE. Chang, Chu-chun (Northwestern Univ., Hsian, China). Hua Hsueh Hsueh Pao, 31: 547-9 (1965). (In Chinese).

The paper strip (30 cm $\times$ 25 cm) is treated successively with 30% SnCl_4 solution, 13% NaH_2PO_4 solution in 0.5M-NaOH, and 3M-HCl, then finally washed with H_2O until the pH of the washings is 6. The sample solution (1 drop) containing ≈ 20 mCi of the carrier-free nuclides per ml is applied to the prepared paper, and the chromatogram developed at 20°C for 90 min with 0.1M to 2M NH_4NO_3 , HNO_3 , or HCl by the ascending technique. Good separations were achieved, but the R_f values for Sr were increased by increasing the concentration of the developer. Development with 1M NH_4NO_3 containing a small amount of methanol, ethanol, or acetone gave lower R_f values for Sr. (Analytical Abstr.)

45032 APPLICATION OF THIN-LAYER CHROMATOGRAPHY TO THE SEPARATION OF ORGANIC IONS. II. SEPARATION OF TRACE AMOUNTS (ppm) OF RADIOACTIVE Mn AND Hg IN SOLID MATRIXES OF Al AND Ag. Bottura, Giorgio (Centro Nazionale di Chimica delle Radiazioni e dei Radioelementi, Bologna). Ann. Chim. (Rome), 57: 148-58 (Feb. 1967). (In Italian).

A neutron activation method, combined with thin-layer chromatography for radiochemical separation, was developed, especially for determining trace amounts of Mn in Al and of Hg in Ag (both pairs in concentration ratios of 10^{-5} to 10^5). The elements present in traces were separated from the base elements by thin-layer chromatography on Kieselgel, with particular attention to the most suitable complexing agents and to the chemical activation of the layer. With neutron fluxes of 10^7 to 10^8 n·cm⁻²·sec⁻¹, it was possible to detect ^{54}Mn in Al base mixtures in quantities as low as 1 ppm and ^{203}Hg in Ag in quantities as low as 10 ppm. This method demonstrated the possibility of combining thin-layer chromatography, as a rapid method of separation, with neutron activation analysis of inorganic systems, for the determination of trace amounts of certain elements. (BDD)

38879 USE OF EXTRACTION CHROMATOGRAPHY FOR IMPROVING YTTRIUM ANALYSIS SENSITIVITY TO RARE EARTH IMPURITIES. Zemskova, M. G.; Lebedev, N. A.; Melamed, Sh. G.; Saunkin, O. F.; Sukhov, G. V.; Khalkin, V. A.; Kherrmann, E.; Shmanenkova, G. I. (Joint Inst. for Nuclear Research, Dubna, USSR. State Scientific-Research and Planning Inst. of the Rare-Metals Industry, Moscow). Zavod. Lab., 33: 667-71 (1967). (In Russian).

Apparatus and methods for the combined analysis of pure samples of Y with admixtures of rare earths from La to Ho were developed. Preliminary separation of the admixtures by the method of extraction chromatography guarantees an increase in the sensitivity of the determination by 50 to 100 times. Neutron activation of the rare earth concentrate with subsequent separation on ion exchange columns makes possible an increase in the sensitivity of the determination of the majority of the elements by 10^2 to 10^4 times. (tr-auth)

32106 NEUTRON ACTIVATION DETERMINATION OF SCANDIUM IN METEORITES WITH APPLICATION OF SUBSTOICHIOMETRIC SEPARATION AND γ -SPECTROMETRY. Lavrukhina, A. K.; Kalicheva, I. S.; Kolesov, G. M. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 6, 651-4 (June 1967). (In Russian).

A simple highly sensitive (up to $10^{-8}\%$) method of the neutron activation determination of scandium in meteorites using substoichiometric chromatographic separation and γ spectrometry is discussed. Scandium content was determined in specimens of the Yarymlinsk and Sikhote-Alin iron meteorite rains and in stony meteorites-chondrites. (auth)

24101 SEPARATION OF RADIOACTIVE IONS. Riesenhuber, Heinz; Grossmann, Dietrich. British Patent 1,064,444. Apr. 5, 1967. Priority date Mar. 20, 1963, Germany.

A process for separation of radioactive ions from solutions consists of passing the solutions through a filter on which is disposed a sparingly soluble salt of the ion consisting of nonradioactive isotopes. The filter is preferably a membrane filter, and the solution is passed through the filter at a velocity of 1 to 100 ml/cm²/min. (B.L.M.)

39019 RADIOCHEMICAL SEPARATION OF STRONTIUM BY ISOTOPIC EXCHANGE. Qureshi, I. H.; Shahid, M. S.; Hasany, S. M. (Atomic Energy Centre, Lahore). *Talanta*, 14: 951-6 (Aug. 1967).

Isotopic exchange has been used for the rapid separation of minute quantities of radiostrontium. A number of variables such as agitation time, concentration of strontium in both phases, mode of preparation, and aging of the precipitates, were studied and optimized. With an optimized procedure, exchange yields of 96 and 94%, respectively, were obtained when strontium sulphate and strontium oxalate precipitates were used for the exchange. Decontamination studies made with radioactive tracers of 15 elements showed that the sulphate precipitate is more selective than the oxalate, most of the elements showing <1% contamination, except ^{140}Ba – ^{140}La and ^{110}Ag , which showed high contamination. This simple procedure has also been applied for the determination of radioactive strontium in rainwater samples. (auth) (UK)

28074 RADIOCHEMICAL SEPARATION OF CADMIUM BY LIQUID-LIQUID EXTRACTION. Mirza, M. Y. (Atomic Energy Commission, Risoe, Denmark); Sani, A. R. *Int. J. Appl. Radiat. Isotop.*, 18: 437-9 (June 1967).

Methods are described for the extraction of In, Cd, Ag, Pd, Rh, Ru, Zr, Nb, Yt, and Sr from 1 to 10 M HCl solution using triisooctylamine (TIOA), with special reference to devising a radiochemical procedure for the separation of Cd from these other elements. Suitable radioisotopes of the elements were employed in tracer concentrations. Results are tabulated, and extraction curves are illustrated as a function of HCl concentration. From the data it was apparent that from 1M HCl only In, Cd, Ag, Ru, and Rh would be extracted (Ru, however, was previously separated by volatility methods). Back-extraction with water gave 95, 99, 97, and ~15% recovery of In, Cd, Ag, and Pd, leaving Rh in the organic phase. During the separation In(OH)₃ was used to carry down traces of Nb, Zr, and Yt, along with In and elements normally soluble in NH₄OH (also used as back-extractant); during this scavenging operation Cd carry-down did not exceed 5%. The time required for the separation was 25 min. The procedure gave good decontamination, and 70 to 75% of the Cd activity was recovered. The procedure may be applied advantageously for the study of short-lived neutron-deficient isotopes of Cd. (UK)

28072 RAPID SEPARATION OF ^{137}mBa FROM A COLUMN LOADED WITH ^{137}Cs . Bastian, J.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). *Radiochim. Acta*, 6: 216 (Dec. 1966). (In German).

The separation of ^{137}mBa from the long-lived mother nuclide ^{137}Cs in a column filled with titanium hexacyanoferrate was investigated. The column was eluted with HCl. Results of the separation were tabulated for periods after the filling of the column of one day to 155 days. The data showed that initially 5% of the ^{137}mBa present in the radiochemical equilibrium was eluted, but later only 1% was eluted. The low percentage of the ^{137}mBa in the eluant was attributed to the fact that the elution was done very rapidly. The use of a fine-grain titanium hexacyanoferrate should improve the yield. (J.S.R.)

21869 SUBSTOICHIOMETRIC DETERMINATION OF MANGANESE IN THE REAGENTS AND IN THE TARGET MATERIAL IN ^{55}Mn PRODUCTION BY ACTIVATION ANALYSIS. Mudrová, B.; Kukula, F. (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). *Isotopenpraxis*, 3: 51-3 (Feb. 1967). (In German).

The determination of trace amounts of manganese by activation analysis followed by chemical separation is described. The separation principle includes substochiometric extraction of the bivalent manganese by thenoyltrifluoroacetone (TTA) in ethylacetate. The method is simple, rapid, and enables the selective separation of manganese. It was applied for the determination of manganese in both the target material and the reagents used for ^{55}Mn production. (auth)

24067 (NIRS-5, pp 10-16) CHEMISTRY. (National Inst. of Radiological Sciences, Chiba (Japan)).

Research progress is reported on: separation of ^{86}Sr and ^{90}Y by paper electrophoresis; separation of Na, K, Rb, and Cs by thin-layer chromatography; separation of radiocesium using copper ferrocyanide anion exchange resin; synthesis and reactivities of N-ethyl-AET derivatives; NMR study of poly-D-glutamic acid; reactions of amino acids and related substances with pyridoxal; and ^{110}B determination in human lung by electrochemical displacement. (M.C.G.)

43027 SOME ASPECTS OF RADIOCHEMICAL SEPARATION METHODS. Betteridge, D. (University Coll. of Swansea, Eng.). *Chem. Zvesti*, 21: 629-37 (1967).

Ion-exchange and solvent-extraction radiochemical separation methods are discussed. Zirconium phosphate, ferrocyanide, and chromium polyphosphate glass inorganic ion exchangers are considered. Reverse-phase partition chromatography, countercurrent distribution, and solvent effects in solvent-extraction processes are discussed. (M.C.G.)

45049 RADIOCHEMICAL METHOD FOR DETERMINATION OF ARSENIC, BROMINE, MERCURY, ANTIMONY, AND SELENIUM IN NEUTRON-IRRADIATED BIOLOGICAL MATERIAL. Samsahl, Knut (Aktiebolaget Atomenergi, Stockholm). *Anal. Chem.*, 39: 1480-3 (Oct. 1967).

A radiochemical method for the determination of As, Br, Hg, Sb, and Se in biological material was developed. It is based on a previously reported procedure for the simultaneous distillation as oxides or bromides of 12 trace elements from sulfuric acid solution. (J.G.B.)

Isotope Dilution

32082 (AERE-AM-104) DETERMINATION OF YTTRIUM IN ALLOY STEELS. Spicer, G. S. (Atomic Energy Research Establishment, Harwell (England)). June 1967. 8p. Dep. CFSSTL, UK 1s,2d.

A procedure is described that uses an isotope dilution technique to determine yttrium in steels which may also contain aluminum. The yttrium is separated as the fluoride and a source in suitable form prepared and counted. The specific activity of this source is compared with standards prepared from a known amount of yttrium. The method has been applied to 15/4/1 chromium-aluminum-yttrium steels and 20/25/1 stainless steels containing up to 1% of yttrium. The accuracy and precision have been determined at the 0.1 and 1% levels. A coefficient of variation of about 3% was obtained at both levels. The method was found to have a positive bias of 1% at the 1% yttrium level and 2% at the 0.1% yttrium level. (P.C.H.)

38920 SUBSTOICHIOMETRIC DETERMINATION OF TRACES OF GOLD BY RADIOACTIVE ISOTOPE-DILUTION ANALYSIS. Beardsley, D. A.; Briscoe, G. B.; Ruzicka, J.; Williams, M. (Univ. of Aston, Birmingham, Eng.). *Talanta*, 14: 879-86 (Aug. 1967).

A radioactive isotope-dilution method for the determination of traces of gold has been developed. It is based on the solvent extraction of gold diethyldithiocarbamate from 0.5N sulphuric acid containing ascorbic acid, using a substochiometric amount of zinc diethyldithiocarbamate in chloroform. The separation was applied to the analysis of gold-doped semiconductor-grade silicon and of gold-bearing ores. Amounts of gold down to 5×10^{-7} g/20 ml of test solution can be determined. (auth) (UK)

45055 SUBSTOICHIOMETRIC SEPARATION IN THE METHOD OF ISOTOPE DILUTION WITH RADIOMETRIC CORRECTION OF THE RESULTS OF ANALYSIS. Shamaev, V. I. (Moscow Order of Lenin Chemical Engineering Inst.). *Zh. Anal. Khim.*, 22: 1310-19 (Sept. 1967). (In Russian).

The use of substochiometric separation for a modification of the isotope dilution method based on radiometric correction of the results is discussed. Certain peculiarities of using substochiometric separation in the method of radiometric correction and its advantages (higher sensitivity and selectivity of determinations, less time and work needed for the analysis) are considered. Conditions for substochiometric separation were found, the sensitivity of the determinations and the maximum permissible concentrations of interfering ions were calculated. Some examples of analysis by radiometric correction with substochiometric separation are given, and the experimental data (pH range, sensitivity, and effect of interfering ions) are compared with the calculated ones. (auth)

45042 LANTHANIDES IN BASALTS OF JAPAN WITH THREE DISTINCT TYPES. Masuda, Akimasa (Tokyo Univ.). *Geochem. J. (Nagoya)*, 1: 11-26 (1966).

The lanthanides La, Ce, Nd, Sm, Eu, Gd, Dy, Er, and Yb were determined quantitatively in 6 basalts of Japan by isotope dilution methods. The results suggested that the high-alumina olivine basalt was a primary liquid-type material, the primary tholeiite was a primary solid-type material, and the alkali olivine basalt, previously supposed to be primary, was a secondary liquid-type material. This observation is in agreement with conclusions drawn from analysis of the relation between U and Th concentrations. The original depths for the 3 magmas were estimated to be 200, 150, and 220 km, respectively, from the relative enrichment of lanthanides. Genetically a close connection was corroborated for tholeiite and high-alumina basalt. (TSS)

45029 RADIOACTIVE SUBSTOICHIOMETRIC ISOTOPE-DILUTION PROCEDURE FOR THE DETERMINATION OF RARE EARTH METALS. Briscoe, G. B.; Dodson, A. (Univ. of Aston, Birmingham, Eng.). *Talanta*, 14: 1051-60 (Sept. 1967).

A theory is developed which describes the equilibrium conditions when solutions containing trace metals and substochiometric amounts of EDTA are extracted with thenoyltrifluoroacetone. Experimental evidence is given to support the theory. A method for the determination of microgram quantities of rare earth metals is outlined as an application. (auth) (UK)

42907 RADIOACTIVE ISOTOPE DILUTION ANALYSIS. R.C.C. Review No. 2. Revised Edition. Gorsuch, T. T. Amer-sham, Bucks, Eng., The Radiochemical Centre, 1967. 12p. UK. Radioisotope dilution and its modifications are described as a sensitive technique for the determination of many substances in mixtures. A few examples are described in detail with many more uses suggested. (P.C.S.)

35897 RADIOMETRIC ERRORS IN DIFFERENT MODIFICATIONS OF THE ISOTOPE DILUTION METHOD. Shamaev, V. I. (Mendeleev Chemical-Technological Inst., Moscow). Zh. Anal. Khim., 22: 988-92 (July 1967). (In Russian).

Different modifications of the isotope dilution method were compared. It was shown that the accuracy of determinations is higher when a version of the method based on the radiometric recording of the unseparated part of the determined element (the method of radiometric correction) is used. The radiometric error of the analysis by the method of radiometric correction depends on the separated amount of the determined element. (auth)

Gages

32246 RADIOMETRIC TECHNIQUES IN PROSPECTING FOR AND EXTRACTING COAL AND ORE. Florkowski, T. (International Atomic Energy Agency, Vienna). Atomwirt., Atomtech., 12: 247-54 (May 1967). (In German).

Radiometric techniques developed over the last twenty years have proved useful in prospecting for metal ores and coal and in extracting the products. They are used in borehole measurements for quantitative and qualitative geological prospecting and also in the exploitation of ores and coal. In borehole prospecting the measuring techniques may be classified as follows: gamma measurements of the natural gamma radiation; gamma-gamma measurements of scattered radiation which is excited by gamma sources; neutron measurement techniques in which either the gamma rays emitted by neutron capture or thermalization are measured. The spectroscopy of the neutron capture gamma radiation has attained great significance in the chemical analysis of minerals. In this connection activation analysis is a promising method for the determination of elementary composition. Portable equipment for determining composition of metal ores at mine sites by measuring the intensity of characteristic x-radiation excited by radioisotopic x-ray sources. These radiation sources use a soft gamma radiation on x-radiation produced by k-capture. Bremsstrahlung sources are also used. Gas proportional counters are used as detectors. The equipment mentioned for one analysis is intended for tin, zinc, iron, and copper ones. These applications are described in detail. In addition radiometric methods for the determination of the ash content of coal are also treated. (auth)

23852 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR X-RAY ANALYSIS. Rhodes, John Rathbone (to United Kingdom Atomic Energy Authority). British Patent 1,065,918. Apr. 19, 1967. Filed Sept. 11, 1964.

A back-scatter geometry apparatus is provided for x-ray analysis that comprises a radioisotope source of x rays in a holder positioned so that primary radiation from the source strikes a generally concave target to produce secondary radiation from the target. A radiation measuring means with an external measuring surface extending partially around the perimeter of the target is provided, and means are provided to accommodate a shaped filter adjacent to the external radiation measuring surface. Shielding is provided to prevent the primary and secondary radiation from entering the measuring means directly. The source may consist of ^{241}Am or ^{109}Cd , and the target may be only one element or may be a mixture selected to give secondary x rays of two distinct energy components for the determination of two different elements present in the same sample. Suitable targets are Se, Cs, Sn, or mixtures of these. (B.L.M.)

28094 POLEVYE YADERNYE GEOFIZICHESKIE METODY. (Field Methods of Nuclear Geophysics). Baranov, V. I. (ed.). Moscow, Izdatel'stvo Nauka, 1966. 224p.

New developments at the Laboratory of Nuclear Geophysics are examined. Descriptions are given of portable γ spectrometers, methods for rock density determination by γ attenuation, portable γ densitometers, methods for the determination of the ash content of coals and their original outcrop by reflected β irradiation, nuclear methods for the determination of boron and boron magnetite deposits, and new methods for the determination of the moisture content of rocks under field conditions. (tr-auth)

39283 RADIOISOTOPE-BASED EQUIPMENT IN THE USSR. Gerrard, Martha. Isotop. Radiat. Technol., 4: 249-50 (Spring 1967).

Forty-eight relays and gages, of various types, based on radioisotopes were marketed last year in the USSR. The cost of this equipment varies from \$250 to \$11,000. (auth)

24179 RADIATIONNAYA AVTOMATIKA I KONTROL' V GORNOM DELA. (Radiation Automatics and Control in Mining). Segalin, V. G. Moscow, Izdatel'stvo Nedra, 1966. 398p.

General and particular questions on the use of radioisotopes for the automation and technological control in mining were examined. The future use of radioisotopes in mining was discussed and their classification given. The characteristics of radioisotopes and methods for their use were discussed. (tr-auth)

26070 RADIOISOTOPE X-RAY FLUORESCENCE AND RADIATION SCATTER TECHNIQUES IN MINING AND METALLURGY. Berry, P. F. (Atomic Energy of Canada Ltd., Ottawa). Can. Mining Met. Bull., 60: 441-9 (Apr. 1967).

Many examples of radioisotope x-ray fluorescence for analysis of metallic minerals, finished metals, and alloys and also for the continuous measurement of metallic coatings, such as Sn and Zn, on steel are described. Radiation scatter techniques are also described for certain analyses and for thickness and density measurements. (auth)

45439 INDUSTRIAL USE OF RADIOISOTOPE DEVICES IN JAPAN. Gerrard, Martha. Isotop. Radiat. Technol., 4: 195-7 (Winter 1966-1967).

The reasons given by a number of Japanese industrialists for their failure to fully exploit radioisotope devices are summarized. They are derived from a questionnaire sent to 746 organizations by the Japan Radioisotope Association in January 1964. Of the 84% who replied 36% were using radioisotope devices. Of the 547 instruments in use 25% were imported. All of the vacuum and gas chromatography meters and leak detectors were imported, 17% of the thickness gages, 14% of the level gages, but none of the snow-fall meters. Lack of need, adequacy of other methods, and high cost were among the reasons given for not using the devices. (M.M.B.)

45445 RADIOIZOTOPNAYA AVTOMATIKA V KUZNECHNO-SHTAMPOVOCHNOM PROIZVODSTVE. (Radioisotope Automation in Forging-Die Industry). Artes, A. E. Moscow, Atomizdat, 1967. 180p.

The latest possibilities for the development of automation systems using radioisotopes were described. The results of scientific studies and pilot installations using these new automation systems are also reported. On the basis of the exploitation of a series of installations with radioisotopic devices, practical recommendations were given for their future installation and use. Their economic efficiency was also considered. (tr-auth)

45442 A FUNDAMENTAL STUDY ON INDUSTRIAL MEASUREMENTS BY MEANS OF BACKSCATTERED GAMMA RAYS. PART I. Shibata, Keizo; Wakabayashi, Nobuo; Fujii, Mizuhiko; Ueda, Katsuhiko (Kobe Univ., Japan). Radioisotopos (Tokyo), 16: 204-8 (May 1967). (In Japanese).

As a fundamental study of thickness, level, or density by means of backscattered gamma-rays, the spectra of the gamma rays which were scattered by steel plates with or without water behind these plates, were measured. The incoming beam from ^{137}Cs (0.1 Ci) was collimated by a hole 6 mm in diameter. The experimental condition was based on the calculated results of the intensity of single-scattered rays in the incident plane. In calculation, the geometrical condition of the apparatus (the sizes of detector and collimator etc.) was taken into account. When the scattering angle was not large, the energy spectrum showed two main peaks: the higher energy peak by single-scattered rays and the lower energy one by multiple-scattered rays. It was found that the energy band of the higher peak was suitable for thickness measurement of vessel wall. It was also possible by some ways of geometrical arrangement of the apparatus to detect mainly the scattered rays by the vessel wall. It was shown that geometrical arrangement in wall-thickness measurement by means of back-scattered gamma-rays could be evaluated from the standpoint of the error caused by presence of liquid in the vessel. Hereby, the experimental results about the geometrical effects were examined, and the optimum geometrical arrangement was found. (auth)

43204 GENERATION AND INDUSTRIAL UTILIZATION OF SOFT X RAYS FROM ISOTOPE SOURCES. Florkowski, Tadeusz. Krakow, Mining and Smelting Academy, 1965. (In Polish).

Thesis. The principles of the construction of isotope x-ray sources are discussed, taking into account the spectrum of the radiation generated, yields, and other physical parameters. The methods of detection and spectrometry of x-radiation using proportional radiation detectors or threshold and differential filters are described. Examples are given of the application of x-radiation from isotope sources in thickness measurements, and fluorescence and absorption analysis of industrial materials. Safety precautions for working with beta- and x-ray sources are given, and a method for calculating the requisite shielding is proposed. The possibility of constructing field isotope instruments for the fluorescence analysis of metal ores is considered. (JPRS)

41096 (EUR-3486.f) MESURE DE LA FRACTION DE VIDE DANS UN ECOULEMENT DOUBLE PHASE NaK-ARGON. (Void Fraction Measurements in a Two-Phase Flow NaK/Argon). Milliot, B.; Lazarus, J.; Navarre, J.-Ph. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Apr. 11, 1967. 63p. (In French). Dep.

Several measuring methods have been proved and calibrated for determining the void fraction in vertical two-phase flow of NaK. The emulsion was created by injecting argon in the liquid metal. Results have been obtained in bubble flow using EM flowmeters, changes in electrical resistance, γ -rays attenuation and two-phase pressure drop. All results are compared with each other and checked with the theoretical model of Marchaterre and Hoglund. As to the slip ratio some difference has been observed. Moreover all results have been plotted in the Lockhart-Martinelli diagram. (auth)

41076 AN IMPROVEMENT OF THE CONTINUOUS-IONIZATION METHOD FOR LINEARITY AT LOW GAS VELOCITIES. Hrtbar, M. (Univ. of Ljubljana, Yugoslavia. Inst. Josef Stefan, Ljubljana, Yugoslavia). Int. J. Appl. Radiat. Isotop., 18: 631-8 (Sept. 1967).

A modified continuous-ionization method for gas flow-rate measurement is described. It is shown that an extended radioactive source, located in the pipe immediately upstream of the collecting electrode, gives a linear collector current vs. velocity response for small gas velocities. Linearity within 1% can be achieved up to a definite velocity, and extension of the linearity to higher velocities is possible by adding a second source upstream of the first. The effects of the gas composition, pressure and temperature are discussed. It is shown that transients exist in the collector current when the step changes in velocity are applied outside the linear range. (auth)

41066 APPLICATION OF A RADIATION RELAY TO AN INTERLOCK SYSTEM. Minakoshi, Shin (Kobe Industries Corp., Japan). Otomeshon, 11: 75-8 (Oct. 1966). (In Japanese).

A radiation relay is described which is employed in industry for the same purpose as the light ray relay. The main advantage to the radiation relay is its high sensitivity which is not affected by smoke, dust, and high temperatures. An example of this is seen in the interlock system, using a radiation relay, for pushing the produced coke out of a coke oven. The interlock system, employing a radiation relay, consists of a radiation source, radiation detector, and radiation amplification and indication systems. In the detection section, two scintillation probes and amplifiers are installed, each series, containing a probe and amplifier, functions as a separate system; thus, forming a selfchecking system. The radiation from the source passes through the space in the upper part of the coke oven, reaching the detector. The interlock system works as follows: if the radiation, i.e., gamma rays do not reach the detector, the device for pushing out the coke cannot be operated. This will occur under the following conditions: the coke guide-truck and the pushing-out device are not on a line, the oven lids are not removed, and preparation of the coke guide is not complete and the gamma-ray absorbing plate is not opened. (NSA of Japan)

Thickness

43296 X-RAY THICKNESS GAGE. STRIP THICKNESS MEASURING EQUIPMENT USING X RAYS. Kido, Hiroshi (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Int. Ed., No. 30, 11-17 (Apr.-June 1967).

Measurement of strip thickness is essential to process control in rolling or sheet lines in iron-and-steel or nonferrous-metal industries. The x-ray thickness gage, performing the measurement continuously without contacting with the strip, has very high utility. In addition to a description of the gage some examples of actual application are presented. (auth)

28285 (EUR-3289.d) DICKENMESSUNG AN HEISSEN GLASBAHNEN BEI DER HERSTELLUNG VON TAFELGLAS. (Thickness Measurements on Hot Glass Sheets in the Manufacture of Plate Glass). Langel, H. (Frieleke und Hoepfner G.m.b.H., Erlangen-Bruck (West Germany)). Feb. 1967. 38p. (In German). Dep.

Three prototype devices employing α transmission techniques using ^{241}Am sources were developed for measuring thicknesses in plate glass manufacturing. The three devices all show promise. One device, which is very expensive, is used in the cooling furnace. The other devices, which are less expensive, are used behind the cooling furnace and during vertical drawing. (F.S.)

28290 MEASURING SYSTEM ANALYSIS OF X-RAY THICKNESS GAGES. Yoshiyama, Yuji; Obata, Hajime (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Giho, 7: 271-87 (Oct. 1966).

Several errors due to the varieties of the measuring systems of X-ray thickness gauges are analysed and experimentally tested in part. The measuring system of X-ray gauges usually involves the two beam system or one beam system. The sensitivity, deviation error, statistical error, and measuring error are discussed. From the point of view of accuracy, the two beam system is superior to the one beam system when the coincidence error is more than 0.4 times of random error, as the accuracy is limited by the fraction of many factors in one beam system. (NSA of Japan)

24241 WEIGHT PER UNIT AREA GAGE WITH ABSOLUTE INDICATION. Vogt, W. (VEB Vakutronik WIB, Dresden). Isotopenpraxis, 3: 47-9 (Feb. 1967). (In German).

A laboratory model of an actual-value indicator (absolute value meter) for measuring the mass per unit area is described. The indicator may be operated in connection with all measuring heads of the mass per unit area gages designed and manufactured by VEB Vakutronik WIB Dresden. The working principle of the gage based on a programmed control is described. Using this indicator the same accuracy is attainable as that of the well-known deviation indicators usually used in connection with the mass per unit area gage VA-T-70B. (tr-auth)

36277 THE ^{85}Kr BREMSSTRAHLUNG APPLIED FOR EXTENDING THE RANGE OF THICKNESS MEASUREMENTS. Boehme, G. (VEB Vakutronik, Dresden). Isotopenpraxis, 3: 124-7 (Apr. 1967). (In German).

The construction of the ^{85}Kr bremsstrahlung sources used is described. Some applications for the measurement of the thickness of heavy-metal and aluminium strips are given, and the measuring ranges obtained from these studies are discussed with regard to the automatic mass per unit area gage VA-T-75. (auth)

32092 RADIOMETRIC METHOD FOR GRAVIMETRIC ANALYSIS OF DUST CONCENTRATION. Aleksandrov, N. N.; Bogdanov, V. G. Tr. Gl. Geofiz. Observ., No. 185, 104-9 (1966). (In Russian).

Radiometric determinations of dust thickness in a filter according to the absorption curves in aluminum were made using ^{137}Cs isotopes with $\Delta_{\text{eff}} = 17 \text{ mg/cm}^2$ and front-window Geiger counter with a mica window thickness of 2.1 mg/cm^2 . The order of error of determination of the thickness by gravimetric methods was $\pm 0.2 \text{ mg/cm}^2$ and by radiometric methods $\pm 0.5 \text{ mg/cm}^2$. (tr-auth)

28286 (RT/ING-(66)10) MISURA DELLA FRAZIONE VOLUMETRICA DI VAPORE COL METODO DELL'ATTENUAZIONE γ O X. (Volumetric Fraction Measurement of Vapor by γ or X-Ray Attenuation Method). Baran, W. J.; Lupoli, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 142p. (In Italian). Dep.

A general method for calculating energy and activity of a γ -source for void fraction measurement by the attenuation method is described. The results obtained for test-sections of different shapes and dimensions are discussed. Besides a detailed analysis of a scintillation counter for detecting γ -rays of low energy is made. (auth)

Density

40997 (AEC-tr-6899) USE OF THE SIMILARITY THEORY IN THE GAMMA METHOD OF DETERMINING DENSITY. Artzibashev, V. A. Translated from Vop. Rud. Geofiz., Gos. Geol. Kom. SSSR, No. 5, 88-95 (1965). 14p. Dep. CFSTI. JCL \$2.60 fs. \$0.80 mf.

The most effective use of the principles of similarity during the standardization of problems and generalization of materials in the gamma-method of density measurement is possible when the equation of gamma-field can be presented in the invariant form. Under these conditions the gamma-field is determined by two invariant complexes—the extinction factor and the surface density of the absorbing layer. The region of utilization of similar transformation of gamma-field related to the density change of the media and the intensity of the source of radiation considerably widens if one is limited by the approximate fulfillment of the requirements of the theory of similarity. Experiments partially confirmed that it is possible to violate geometrical similarity of the sound measuring system or media, and also the permissible violation of the geometrical similarity when the homogeneous media are replaced by the layer-type media. (F.S.)

24112 ION DISTRIBUTION, MOISTURE CONTENT, AND DENSITY OF SOIL COLUMNS MEASURED WITH GAMMA RADIATION. Shalhevet, J.; Yaron, B. (Volcani Inst. of Agricultural Research, Rehovoth, Israel). *Soil Sci. Soc. Amer., Proc.*, 31: 153-6(Mar.-Apr. 1967).

Anion distribution in soil columns was measured nondestructively by using a radioactive tracer, $^{60}\text{Co}(\text{CN})_3^-$. The breakthrough curves of Cl^- and $^{60}\text{Co}(\text{CN})_3^-$ were very similar, indicating the possible use of the ^{60}Co complex ion as a qualitative model for anion movement. The external measurement of gamma activity was compared to measurements of 1:1 water extracts of the sectioned columns. The gamma activity of the tracer was measured along uniformly packed soil columns through a few drying and wetting cycles. Drying was done with a stream of warmed air that passed around and through the perforated soil columns. Moisture content and density of the soil in the columns were measured simultaneously by the gamma attenuation method. An equation, the parameters of which were determined empirically, giving density as a linear function of moisture content, may be introduced into the attenuation equation to correct for the variation of density with moisture content. (auth)

28291 A THIN TUBE, INSERTION TYPE γ -RAY DENSITY METER. Arizumi, Masashi; Nishigaki, Yoshihiko (Kajima Construction Co., Ltd., Japan). *Kashima Kensetsu Gijutsu Kenkyusho Nempo*, No. 14, 131-6(Jan. 1966). (In Japanese).

Although various γ -ray density meters and neutron moisture meters are sold, it is necessary to improve these meters so as to be readily used. A thin tube, insertion type γ -ray density meter was constructed in trial to give a small compact and versatile density meter. It consists of a γ -ray source, lead shield, thin tube GM counter (plateau voltage, 400-700 V, and plateau gradient 1-2.5%), preamplifier with a coaxial electric cable, and brass envelope tube (16 mm in diameter and 550 mm long). The effects of various parameters, including the length of the lead shield (17, 20, and 24 cm), material of the access tube (polyvinylchloride, outside diameter 26 mm and thickness 3 mm; and steel, outside diameter 33.5 mm and thickness 8 mm), and the position of the probe in the actual measurements, were studied to obtain the maximum count rate and the optimum time (3 min) of measurement. Good results were given by the use of the lead shield 17 cm long and the access tube made of polyvinylchloride. Examples of practical use of this density meter in the embankment are also given. (NSA of Japan)

34418 SOIL DENSITY MEASUREMENTS WITH GAMMA RAYS. Helbig, Wolfgang; Beer, Manfred (Institut fuer Mechanisierung der Landwirtschaft Potsdam-Bornim, Ger.). *Arch. Landtech.*, 5: 182-203(1965). (In German).

The theoretical and practical aspects of soil density measurements with γ -ray sources are discussed, and construction and operation of two soil density probes utilizing ^{60}Co are described. The use of radioisotopes in agricultural research is considered. With the two ^{60}Co -equipped instruments (DS-1 and DS-2) which are described, measurements could be made at soil depths varying from 7 to 42 cm. With DS-1, a forked probe, the error in measurements varied from 2 to 3.5%. A twin borer was used to make the holes in soil for this instrument. The DS-2 sectional probe was used to record density of earth walls, up to 35 cm thick. Equations were derived as a basis for the measurements, and the relative advantages and disadvantages of ^{60}Co and ^{137}Cs as sources were discussed. Safety features of the instruments are considered. With DS-1 the dose rate at a 1-m distance was ~ 2 mRem/hr without interposition of absorbing substances. In actual use it was found, by film dosimetry, that the operator received less than 5 mRem/month. (BBB)

22185 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR MEASURING DUST CONCENTRATION. (to Institut National de Recherche Chimique Appliquee). British Patent 1,060,880. Mar. 8, 1967. Priority date July 9, 1964, France.

An apparatus is described which measures the concentration of dust in a gas. The gas of which the dust content is to be measured is drawn through a movable or fixed filter layer of paper, felt, textile, or other material. A source of α , β or γ radiation is located on one side of the filter which is loaded with dust. The value of the attenuation of the intensity of radiation by the dust on the filter is measured by a Geiger-Mueller counter. (F.S.)

36419 USE OF A RADIOACTIVE BETA SOURCE TO MONITOR HIGH AIRBORNE-DUST CONCENTRATIONS. Williams, A. J. (Safety in Mines Research Establishment, Harpur Hill, Eng.). *J. Sci. Instrum.*, 44: 562-3(July 1967).

A ^{90}Sr - ^{90}Yt 5 mCi source was used to measure coal dust concentrations in air up to 2 mg cm^{-3} as part of a study of dust explosions. This basically simple method offers several advantages over other available means of continuously measuring high dust concentrations but requires a preliminary calibration. (auth) (UK)

28288 DUAL-ENERGY GAMMA-RAY TRANSMISSION FOR COINCIDENT MEASUREMENT OF WATER CONTENT AND DRY BULK DENSITY OF SOIL. Soane, B. D. (National Inst. of Agricultural Engineering, Penicuik, Scotland). *Nature*, 214: 1273-4(June 17, 1967).

It was found that the ratio between the theoretical absorption coefficients of water and concrete (the total composition of which is similar to that of most soils) depended markedly on photon energy below 100 keV, but only slightly at higher energies. This suggested that it might be possible to measure attenuation using two widely differing primary photon energies and then solve simultaneous equations for the mass thicknesses of soil and water. Where the sample thickness is constant, values of mass thickness can be replaced by units of mass/volume. Sources employed in experimental work were ^{241}Am and ^{137}Cs , giving low and high photon energies, respectively. Detection was by thallium-doped NaI scintillator. Count rates for the 60 and 660 keV photopeaks were measured, in turn, for both the low-energy and high-energy sources. No collimation was employed, but this did not affect the principle or accuracy of the method provided the geometry remained constant. Experimental results are tabulated. It would seem that the accuracy is likely to be acceptable for many purposes, and capable of improvement. (UK)

36453 PERFORMANCE OF AN ON-STREAM RADIOISOTOPE X-RAY FLUORESCENCE ANALYSER. Carr-Brion, K. G. (Warren Spring Lab., Stevenage, Eng.). *Trans. Inst. Mining Met.*, 76: C94-C100(June 1967).

The performance of a radioisotope x-ray fluorescence slurry analyser operated under laboratory and plant conditions is described. Methods used to correct for variations in the x-ray attenuation coefficients and solid content of slurries are described and the advantages and limitations are discussed. (auth)

41161 INDUSTRIAL TESTS OF AN ISOTOPE BELT CONVEYOR BALANCE. Girczys, Janusz; Piatkowski, Andrzej. *Rudy Metale Niezelaz.*, 12: 359-62(July 1967). (In Polish).

Tests were carried out with a prototype isotope belt conveyor balance based on the dependence between the intensity of the scattered γ radiation and the magnitude of the belt load. Results of tests indicate that the prototype balance could be used for weighing zinc-lead ore with an error exceeding $\pm 5\%$. Conditions to be met to improve the accuracy of weighing are indicated. (auth)

41165 IMPROVEMENTS IN AND RELATING TO THE MEASUREMENT OF MATERIAL ON A CONVEYOR. (to Ohmart Corp.) British Patent 1,078,831. Aug. 9, 1967. Priority date July 29, 1963, United States.

A measurement system is described which is used in measuring the weight of solid materials as they are delivered on a conveyor. The system consists of an elongated radiation source and detector which extend horizontally in a transverse direction to the conveyor. Radiations emitted from the source pass through the conveyor and the material carried on the conveyor and then impinge on the detector. The detector produces a current flow correlated with the weight of material per unit length of the conveyor. (F.S.)

45440 NEW IMPROVED RADIOACTIVE VISCOSIMETER. Fula, H. N.; Ponner, I. I. (Polytechnical Inst., Bucharest). *Bul. Inst. Politeh. Bucuresti*, 29: 73-8(Jan.-Feb. 1967).

The proposed radioactive viscosimeter relies on the principle of a ball sinking in the liquid under investigation. The ball sinking rate is determined by measuring a set of $r(t)$ counting rate values depending on ball sinking time with an electronic scaler-detector commanded by an astable multivibrator. Device calibration is carried out by measuring $r(x)$ counting rate function of x -depth at which the ball is suspended in liquid. The accuracy at silicone oil (OE 4018/100.000) viscosity coefficient determination with this viscosimeter is under 2%. (auth)

Moisture

28414 OBSERVATIONS ON THE UTILIZATION OF A NEUTRON PROBE FOR THE STUDY OF WATER ECONOMY OF PLANTS. Barrada, Y.; Decroux, J. (International Atomic Energy Agency, Vienna). *Awamia*, No. 14, 115-47(Jan. 1965). (In French).

An evaluation was made of the use of a neutron probe to investigate the water economy in corn plants in irrigated fields. The device was used particularly to measure available soil water and evapotranspiration, and, on the basis of the data obtained, to estimate field capacity and the wilting point. A 5-mCi radium-beryllium neutron source was used. In general, the results were satisfactory, the device and technic rapidly permitting an evaluation of water conditions in the soil. The readings obtained were proportional to the available water in the soil. Thus the neutron probe was valuable in establishing optimal soil-water conditions by irrigation and determining the optimal plant population density. (BBB)

36120 MEASUREMENT OF SOIL MOISTURE IN THE FIELD BY NEUTRON MODERATION. Long, I. F.; French, B. K. (Rothamsted Experimental Station, Harpenden, Eng.). *J. Soil Sci.*, 18: 149-66 (Mar. 1967).

Design, calibration, working hazards and precautions, and field use of a soil-moisture meter are described. The probe carries a source ($^{241}\text{Am-Be}$) and a detector ($^{10}\text{BF}_3$) in an Al case. Source and detector are as close to each other as possible, giving a desired linear relation between thermal neutron count and the volumetric water content around the probe. The portable scaler incorporates some new features of circuit design that lead to ease of operation and small size; it weighs 5 Kg. Factors involved in calibration or the interpretation of a calibration curve are: resolving time of the scaler, the volume of soil explored by the neutrons, the effect of a moisture gradient, and the possible effect of elements other than H. Field trials were conducted in 2 groups. In 1962 and 1963 frequent measurements were made in bare clay soil and under a nearby barley crop: from the profiles, the extraction of water from the bare soil was limited to the top 30 cm, but the barley roots took water out at least as deeply as the maximum depth of measurement then possible, 90 cm. In 1964 similar measurements under first-year timothy and meadow fescue, irrigated and nonirrigated, showed that the total water abstracted by each was nearly the same, but the timothy took most of its water from the top 40 cm of profile, whereas the fescue took more water from the lower depths. Combining the estimated deficits with known rainfall gave values of periodic evaporation in good agreement with aerodynamic estimates based on temperature, humidity, and wind profiles above the crop, and in fair agreement with potential evaporation-rates calculated from routine weather records. (BBB)

32496 COMPARATIVE EXPERIMENTAL AND THEORETICAL INVESTIGATIONS OF THE DM NEUTRON MOISTURE PROBE. Oelgaard, P. L.; Haahr, V. (Danish Atomic Energy Commission, Roskilde, Denmark). *Nucl. Eng. Design*, 5: 311-24 (May 1967).

Theoretical and experimental investigations of the Danish produced DM subsurface moisture probe are discussed and the results obtained are presented. The DM probe contains an Am-Be fast neutron source and has a glass scintillator containing ^6Li as neutron detector. Through modification of the probe it was possible to vary the source-detector distance in steps. By the use of a three-group diffusion model and a semi-empirical calibration procedure good agreement between measured and calculated curves was obtained. Further, the model was used to study the effect of variations in the dry soil density and in the boron content of soil. Finally the applicability of the model in connection with probe design was considered. (auth)

28292 PROCEDURE FOR CALIBRATING NEUTRON MOISTURE PROBES IN THE FIELD. Cohen, O. P. (Volcani Inst. of Agricultural Research, Rehovot, Israel). *Israel J. Agr. Res.*, 14: 169-78 (Dec. 1964).

A description is given of a procedure for field calibration of the soil moisture probe during the placement of the access tube. The possible displacement of the neutron source from the sensitive center of the probe is taken into account, and an empirical procedure is described for determining the sample volume which yields the least error in the resulting regression. Calibration of three Israel soils with the same probe indicated that each soil requires its own calibration. (auth)

30735 ARRANGEMENT FOR THE MEASUREMENT OF MOISTURE BY MEANS OF NEUTRONS. Netz, Volkhard; Johannes, Eberhard (to Veb Vakutronik Wissenschaftlicher Industriebetrieb Dresden). British Patent 1,073,443. June 28, 1967. Filed Sept. 16, 1964.

An apparatus for determining the moisture content of a substance by means of a neutron scattering technique is described. The apparatus consists of a neutron source, radiation detector, and a control device, in the form of a neutron reflector, spaced from the neutron source so that the sample can be located between the source and reflector. (B.G.D.)

24240 NEUTRON SOIL MOISTURE GAUGES. Zuber, A. (Inst. of Nuclear Research, Krakow); Cameron, J. F. *At. Energy Rev.*, 4: No. 4, 143-67 (Dec. 1966).

Theoretical and practical factors involved in selecting and using neutron soil moisture gauges are considered. These factors include range of moisture contents to be measured, variations in soil and measurement parameters, methods of calibration, and optimum measuring times. A comparison is made of some typical moisture gauge designs. (auth)

39281 GEOMETRICAL ARRANGEMENT AND EFFICIENCY OF MOISTURE DETECTION IN MEASUREMENT SYSTEM OF BETA RAYS. Hattori, Taikichi (Muroan Inst. of Tech., Tokyo). *Denki Gakkai Zasshi*, 87: 833-42 (Feb. 1967). (In Japanese).

Experiments and Monte Carlo calculations were performed on the absorption and scattering of β rays in a geometrical arrangement in which a Pb collimator 2 mm thick was set up in front of a radioactive source ($^{90}\text{Sr}-^{90}\text{Y}$). It was shown that the counting rate of emitted electrons, in accordance with the position of the materials tested, depends upon the diameter of the hole of the collimator. Optimum conditions for detecting moisture content at high efficiency by changing the position of the materials tested and the diameter of the hole are given. The number of electrons detected was calculated by the Monte Carlo method, with consideration of the energy distribution of electrons emitted from the source and the effect of the collimator which controls the number of electrons incident on testing materials. This calculation was made with the aid of a digital computer; the results agreed with the experimental results. The relation between the count rate and the position of materials tested with the diameter change of the collimator was examined experimentally. In the curves of the count rate plotted against the position of tested materials, the smaller the diameter of the hole, the nearer to the detector the position with the maximum counting rate moved from the source. For extremely collimated radiation, the gradient of the curve increased monotonously as distance from the source increased. As the curve became flattest, when the position with maximum count rate was located at the mid-distance between the source and detector, measurement of moisture in continuously moving materials can be carried out with a higher accuracy in this arrangement. Curves of the sensitivity of moisture detection in accordance with the changes in the diameter of the hole and the position of materials are shown as functions of area density. (BBB)

Level

30734 THE POSSIBLE DETERMINATION OF THE LEVEL OF A LIQUID BY THE γ -RAY SCATTERING METHOD. Onicescu, M.; Petriu, I.; Popescu, C. (Inst. of Atomic Physics, Bucharest). *Stud. Cercet. Fiz.*, 19: 41-52 (1967). (In Rumanian).

Experiments were carried out for determining the conditions under which scattering of the γ radiation may be used for the determination of the liquid level in closed vessels. A halide G-M counter was used in conjunction with a $1.37 \pm 0.04 \text{ mCi } ^{60}\text{Co}$ source; the detector and the source were mounted on the same side of the vessel. The intensity component due to scattering gives the useful information for the level determination. Study of the geometry of the system revealed that best results are obtained when the detector is placed as close as possible to the surface of the wall. It was also found that the sensitivity of the system is highest when the source is at the level of the liquid, varying symmetrically around that height. The sensitivity also decreases with increasing shield thickness; the optimum thickness of the shield increases with the thickness of the wall. The method presents the advantage that the activity of the detector is only slightly affected by the thickness of the liquid layer to be measured; for large thin-wall vessels, low-activity sources may be used. In case of small thin-wall containers, the scattering method offers the advantage of higher sensitivity than the attenuation method. (TTT)

28287 MEASUREMENT OF THE HOLD-UP OF RAW MATERIAL IN THE ROTARY KILN. Tanaka, Masaaki; Kobuchi, Kumio (Ube Ind., Ltd., Japan). *FAPIG (Tokyo)*, No. 41, 126 (July 1966). (In Japanese).

An improved method was developed for measuring the moving angle of repose of raw material in the kiln. The measuring instrument was previously placed on the ground. In the new method, the radiation source and detector are located on the circumference outside the kiln and both are rotated at the same rate as the kiln. With the relation between the detected amount and the rotating angle in the x-y axis, the bottom value of the concaved curve shows the moving angle of repose. By this means, the apparent moving angle of repose can be avoided. ^{60}Co 1 Ci is used as the source and a scintillation probe as the detector. The moving angle of repose and the packing-ratio are 6° and 7%, respectively when the kiln is run in the normal operation; they are 45° and 4.5% when the kiln is stopped. These values are far smaller than those usually expected, which indicate the considerable aeration due to CO_2 in the kiln. (NSA of Japan)

28293 ECONOMICS OF ISOTOPIC BLAST-FURNACE BATCH LEVEL INDICATORS. Abelovszki, Laszlo (Isotope Inst. of the National Atomic Energy Commission, Hungary). *Atomtech. Tajek.*, 9: 615-23(1966). (In Hungarian).

A level indicator operating with two fixed ^{60}Co sources was installed in April 1964, in one of the blast furnaces of the Danubian Iron Works, to automatically record the batch level and to control the loading unit. The information obtained by the sensors was recorded on paper tape, then transmitted to the control room, where instructions to add ore, coke, or limestone are given. The sensors were water-cooled. After more than one year of operation, the device was found to operate more reliably than previously used mechanical probes; it also gives information about the shape of the surface because four points are used for measurements. Uneven operation of the furnace may easily be detected and the unit may be repaired without interfering with the loading operation. By use of electronic data processing, the level was maintained at the desired value. After the instrument was installed iron production of the furnace increased by 2.6% and the specific coke consumption was improved by 6.5%. (auth)

43295 LIMITS OF THE USEABILITY OF ^{60}Co AND ^{137}Cs FOR NONCONTINUOUS LEVEL CONTROL. Plaksin, I. N.; Gol'din, M. L. *At. Energ. (USSR)*, 22: 505-6(June 1967). (In Russian).

In view of their useful service life of 10 to 15 years, ^{60}Co and ^{137}Cs are widely used as radiation sources for level measurements. Calculations were carried out to determine the conditions of optimum application of these sources, keeping constant the distance between the source and the detector, the surface area and the wall thickness. The calculations revealed that for a service life of 15 years and an iron wall thickness up to 13 cm, the ^{137}Cs sources are preferable to the ^{60}Co ones. From the viewpoint of safety, the latter source is recommended for a thickness of 25 cm for a service life of 15 years and 19 cm for 2 years of operation. The effect of the temperature was not taken into account for the calculations. (TTT)

41287 KIT ASSEMBLING SYSTEM OF A RADIOISOTOPE INSTRUMENT WITH PULSE SCANNERS UTILIZED FOR INDUSTRIAL MEASUREMENT AND CONTROL. Mlckovsky, Miloslav. *Jad. Energ.*, 13: 301-7(Aug. 1967). (In Czech).

Descriptions are given of the design and performance of radio-metric level indicator with pulse-transducers developed at the Tesle-Liberec plant laboratory. The device will be ready for commercial production in the second half of 1967. (tr-auth)

Concentration

38905 NON-DESTRUCTIVE DETERMINATION OF HYDROGEN IN ORGANIC SOLVENTS BY THERMAL NEUTRON SCATTERING. Ishii, Daido; Hirose, Yoji; Mori, Hideo (Nagoya Univ., Japan). *Bunseki Kagaku*, 16: 686-91(July 1967). (In Japanese).

A rapid, nondestructive method based on the scattering process of neutrons by hydrogen nucleus was investigated for the determination of hydrogen content in organic solvents. The organic solvent samples were irradiated with a collimated thermal neutron beam from an Am-Be source, and the scattered thermal neutrons were measured by a BF_3 -counter. The counting rate was linearly proportional to the content of hydrogen in the range 60 to 110 mg/ml with a 60 ml sample. Graphite blocks were used effectively as the thermal neutron reflector. The influences of coexisting carbon and oxygen atoms upon the calibration curve were not perceptible. (auth)

39136 DETERMINATION OF THE C/H RATIO IN HYDROCARBONS USING BETA- OR NEUTRON RADIATION: COMPARISON OF THE EFFICIENCIES. Brunner, G. (Deutsche Akademie der Wissenschaften, Berlin). *Isotopenpraxis*, 3: 220-3(June 1967). (In German).

The main result of the sensitivity studies executed on the basis of the neutron age theory is that in the hydrogen (or moisture) determination by means of neutron radiation the effect of impurity atoms in good approximation may be regarded as addition of absorbers only. Quantitative results are given and compared with the corresponding data of beta technique. (auth)

23843 QUASI-CONTINUOUS MEASUREMENT OF SMALL CONCENTRATIONS OF SO_2 IN WASTE GASES BY SOFT- γ ABSORPTION ANALYSIS. Dfesia, H.; Bannke, W.; Hallen, D.; Hilgers, W.; Mueller, Dieter (Staatl. Ingenieur-Schule fuer Maschinenwesen, Essen). *Chem.-Ing.-Tech.*, 39: 465-70(Apr. 25, 1967). (In German).

γ -absorption is suitable for determination of SO_2 concentrations of the order of a few tenths of a vol. %. If the concentration is lower than 0.5 vol. % the SO_2 must be concentrated in an absorbent. This role is better filled by hydrogen peroxide than by cyclohexanone, for, although the former has a larger absorption cross section for γ quanta, the SO_2 is bonded chemically and no desorption can take place. The method is somewhat less accurate than gravimetric analysis but has the advantage that it may be used for quasi-continuous operation. (auth)

32097 DETERMINATION OF LEAD IN ORE PULPS BY A TECHNIQUE USING TWO γ -RAY ABSORPTION GAUGES. Ellis, W. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales); Fookes, R. A.; Watt, J. S.; Hardy, E. L.; Stewart, C. C. *Int. J. Appl. Radiat. Isotop.*, 18: 473-8(July 1967).

The lead concentration and density of ore pulps were determined using two γ -ray absorption gauges. One was a conventional density gauge using ^{137}Cs . The other was a lead-sensitive gauge, depending on the preferential absorption by lead of 225 keV γ rays from a novel source of Compton scattered ^{137}Cs γ -rays. It was shown by experiment that the accuracy of measurement of lead concentration is $\pm 4\%$ and of density $\pm 0.9\%$ for ore pulps with lead concentrations in the range 0.05 to 0.16 g/cm³ and densities 1.36 to 1.68 g/cm³. The gauges may be mounted directly on a flotation feed line. By simple electronic combination of the gauge outputs, a signal directly proportional to lead concentration may be obtained. (auth)

32105 ANALYSIS OF PETROLEUM PRODUCTS BY ABSORPTION OF RADIOACTIVE RADIATIONS. V. RADIOACTIVE ABSORPTION METHOD AND APPARATUS FOR THE CONTINUOUS ANALYSIS OF THE HETEROATOM CONTENT OF LIQUID PETROLEUM AND PETROCHEMICAL PRODUCTS. Balint, T. (Hungarian Mineral Oil and Natural Gas Research Inst., Veszprem). *Acta Chim. Acad. Sci. Hung.*, 52: 243-50(1967).

A method for the continuous analysis of petroleum products by absorption of radioactive radiation is given. An apparatus is described that regulates the continuous surface density thus allowing the radiation absorption to depend only on composition of sample. The method described allows density compensation on a mechanical principle when the changes of density are neither too large (they do not exceed the value of ± 0.05 to 0.10 g/ml) nor negligibly small. If sudden great density changes are expected, the regulating and measuring vessels must be in parallel. Compared to other methods, the apparatus has many advantages. The appreciable sensitivity toward density changes must be emphasized. Other advantages are the minimal sensitivity toward the velocity of flow of the liquid to be analyzed and the possibility of elimination of error source emerging from the change of distance between radiation source and detector. The apparatus is simple in construction and seems to be suitable for industrial uses. (D.H.M.)

38890 PRACTICAL EXPERIENCE IN OPERATION AND CONTROL USING A BETA-RADIOMETRIC ANALYZER AND POSSIBILITIES OF ITS USE IN DIFFERENT BRANCHES OF INDUSTRY. Schiller, Pavel (Comenius Univ., Bratislava). *Jad. Energ.*, 13: 103-5(Mar. 1967). (In Czech).

A radiometric control method based on intensity measurement of beta radiation reflected by the substance being analyzed is described. Operational tests of the instrument in different industrial branches, predominantly in pharmacy, are discussed. Test results of the beta-recoil method in determination of ash in coal, the amount of unburned coal in fly ash, and the iron content in ores are considered. (auth)

21901 METHODS OF X-RAY FLUORESCENCE ANALYSIS BY MEANS OF RADIOISOTOPES. Martinelli, P. (CEN, Saclay, France). *Chimia (Aarau)*, 21: 151-9(Apr. 13, 1967). (In French).

X-ray fluorescence analysis is carried out by exciting the inner energetic levels of the atoms (K, L levels) and measuring the intensities of the characteristic x-ray lines emitted by the elements to be analyzed. Excitation is generally obtained by means of x rays or accelerated electrons from generator tubes. These techniques are being developed intensely. But it is also possible to use radioactive sources emitting α , β or photons. Interesting features of the use of radioactive sources are: stability of the exciting spectrum, small size, cheapness, availability of a large variety of spectrum shapes and sources. They are used in portable apparatuses and are particularly attractive for continuous control. However, because of their low intensity, it is not possible to analyze accurately the radiations emitted by the irradiated samples. It is necessary to use methods other than diffraction to determine the intensities of the K and L x-ray lines. So they are mainly used to determine the content of known elements in matrices of relatively stable composition. They can also be applied to the solution of more complex problems. Various techniques using radioactive sources are proposed. A number of industrial applications is already made. By their contribution to automatization, these radioactive techniques have a large interest for the near future. (auth)

41164 STUDIES ON RADIOACTIVE X- AND GAMMA-RAY SOURCES APPLIED TO THE DETERMINATION OF ASH CONTENT OF COAL. Tanemura, Takashi; Saita, Hiroshi (Rigakii Denki Co., Japan). Oyo Butsuri, 36: 444-51 (June 1967). (In Japanese).

In order to find the radioactive γ - or X-ray source suitable to the determination of ash content, of coal by X-ray backscattering, various sources of energy below 60 keV were studied. Monochromatic X-rays of energy between 10 and 35 keV were supplied by γ -excited X-ray sources which consist of the ^{241}Am γ source and various target materials of atomic number in the range of 35 to 56. Commercially available sources as ^{241}Am , $^3\text{H}/\text{Zr}$ and ^{56}Fe were also tested. High sensitivity in the analysis was obtained with the sources of energy between 9 and 30 keV. The main difficulty of this method of analysis is that the intensity of scattered X rays is not solely due to the ash content but dependent on the composition of ash, in particular, the content of Fe_2O_3 . With ^{56}Fe or the γ excited Sr K X-ray source the observed intensity of X-rays was independent of the Fe_2O_3 content. The results lead to the conclusion that an X-ray source of energy slightly below 15 keV is the most suitable for the purpose. (NSA of Japan)

40761 (AEEW-M-752) METHOD OF ESTIMATING HYDROGEN IN SOLID AND LIQUID SAMPLES BY MEANS OF NEUTRON THERMALISATION. Carter, D. H.; Sanders, J. E. (Atomic Energy Establishment, Winfrith (England)). June 1967. 12p. Dep. CFSTI. UK 2s. 6d.

The count-rate of a cadmium-covered ^{238}Pu fission chamber placed in a reactor neutron flux increases when a hydrogen-containing material is inserted due to the thermalisation of epithermal neutrons. This effect forms the basis of a non-destructive method of estimating hydrogen in solid or liquid samples, and trial experiments to demonstrate the principles have been made. The sensitivity is such that hydrogen down to 10 ppm in a typical metal should be detected. A useful feature of the method is its very low response to elements other than hydrogen. (auth)

32123 DETERMINATION OF BORON CONTENT IN BOROSILICATE GLASSES BY NEUTRON TRANSMISSION. Ideno, Kazumi (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 9: 317-20 (June 1967). (In Japanese).

Determination of the boron content in borosilicate glasses was successfully carried out by neutron transmission using the JRR-2 neutron crystal spectrometer. The boron content was calculated from the measured macroscopic neutron cross section of the glass plates. The principal sources of error in this method are the statistical error in the observed neutron transmission and ambiguity of the neutron absorption cross section of natural boron contained in the glasses. If more than 0.1% boron is contained in borosilicate glass, the boron content can be determined with an accuracy of a few percent. (auth)

Temperature

39084. (ORNL-tr-1727) TEMPERATURE CONTROL IN LIQUID METALS BY A RADIOMETRIC METHOD. Kutovoi, V. I.; Stetsenko, V. I. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.). from Izmer. Tekh., No. 8, 17-20 (1965). 7p. Dep. CFSTI. JCL \$1.10 fs, \$0.80 mf.

A radioisotopic method is described for continuous contactless control of liquid metal temperatures by measuring the metal's absorption of gamma radiation. The method is a reliable technique for control of liquid metal temperature and density. (J.R.D.)

Logging

25979 USE OF NEUTRON CAPTURE γ -RAY SPECTROMETRY FOR INVESTIGATING BROWN-COAL SEAMS IN THE BOREHOLE. PART I. Eife, Karl-Heinz (Inst. for Petroleum Chemistry, Moscow). Z. Angew. Geol., 12: 530-6 (1966). (In German).

The possibilities of applying neutron capture γ -ray spectrometry to the location of brown-coal seams in the borehole and to the determination of their ash content were investigated. A discussion of the method is followed by a description of practical measurements from the brown-coal basin of Moscow, showing that brown-coal seams, owing to a pronounced minimum of the neutron- γ -radiation intensity, can be unambiguously located when recording fast-neutron γ rays within the energy range $E_\gamma = 3$ to 10 MeV. The relative intensity $I_{\text{fast}}^{241\text{Am}}/I_{\text{slow}}^{241\text{Am}}$ ($E_\gamma > 3$ MeV) very well correlated with the ash content. The error occurring during the determination of the ash content was $\sim 3\%$ of ash (wt) and did not exceed the systematic error of the ash content demonstrated by core drillings, which was about $\pm 6\%$ of ash (wt) for the Moscow basin. Factors influencing the accuracy of determination of the ash content and requirements to be satisfied by the measuring apparatus were also investigated. (BBB)

39207 APPLICATION OF SCINTILLATION COUNTERS IN RADIOACTIVE BORE-HOLE SURVEYS. Marhoffer, Jozsef (National Petroleum and Gas Industry Trust, Budapest). Atomtech. Tajek., 10: 373-81 (1967). (In Hungarian).

A two-channel scintillation counter was used in logging operations during prospecting for natural gas in the region of Szeged. The instrument allowed simultaneous recording of the natural and the neutron γ intensities at temperatures up to 120°C and pressures of 600 atmospheres. NaI(Tl) crystals of differing size and photomultipliers formed the two channels. The system yielded good results to a depth of 2500 meters; for operations to 3000 m special preparations were required during the drilling. It is planned to use the instrument under conditions, in which the salt content of the drilling mud approaches that of the water table, as in that case its low resolving power prevents the use of the customary G-M counters. The efficiency of the counter was found to depend on the γ energy to be measured. The natural γ radiation of the rocks is usually quite low; in that case the efficiency of the counter is about 70%, but for the relatively high-intensity neutron-induced secondary γ radiation, the efficiency of the counter is reduced to 15 to 18%. (TTT)

28096 METHOD OF AND APPARATUS FOR LOGGING BOREHOLES. Threadgold, Philip; Claytor, Howard Francis (to British Petroleum Co. Ltd.). British Patent 1,071,416. June 7, 1967. Filed Jan. 10, 1963.

28095 METHOD OF AND APPARATUS FOR LOGGING BOREHOLES. Threadgold, Philip; Thomas, Godfrey Stuart (to British Petroleum Co. Ltd.). British Patent 1,071,415. June 7, 1967. Filed Jan. 10, 1963.

A well logging device for several simultaneous measurements aimed at estimation of quantities of oil and gas, for example, available in strata is described. The probe combines resistivity measurements and acoustic analysis with neutron-gamma measurements and used time multiplexing in pulse handling. (R.E.U.)

28097 METHOD OF AND APPARATUS FOR LOGGING BOREHOLES. Ward, Eric Henry (to British Petroleum Co., Ltd.). British Patent 1,071,413. June 7, 1967. Filed Jan. 10, 1963.

A radiometric well logging device is described that overcomes the pulse-degradation problems introduced by long logging cables by multiplexing (in time) of position-modulated electrical pulses from detectors of neutron-activation photons. Means are provided for recording the spectral information. (R.E.U.)

22184 IMPROVEMENTS IN OR RELATING TO METHOD AND APPARATUS FOR PULSED WELL LOGGING. Youmans, Arthur Homer (to Dresser Industries, Inc.). British Patent 1,065,784. Apr. 19, 1967. Filed Apr. 7, 1964.

Equipment is described which is used in geophysical prospecting, particularly in radioactive well logging. The equipment is comprised of a source of neutrons with a method for irradiating a medium with a burst of high-energy neutrons, one or more radiation detectors adapted to detect radiations returning from the medium, and a recording method arranged to record the rate of decline of the radioactivity in correlation with an indication of the depth of the well. (F.S.)

41000 (AEC-tr-6904) ATTEMPT TO USE THE GAMMA-RAY REFLECTION METHOD FOR QUANTITATIVE DETERMINATION OF IRON IN UNDERGROUND BOREHOLES IN THE ORDZHONIKIDZE MINE IN THE KRIVOY ROG BASIN. Ochkur, A. P.; Pshenichnii, G. A.; Komissarzhevskaya, G. F.; Orlov, V. N. Translated from Vop. Rud. Geofiz., Gos. Geol. Kom. SSSR, No. 5, 109-12 (1965). 6p. Dep. CFSTI. JCL \$1.10 fs, \$0.80 mf.

A gamma-ray reflection method was developed for determining the separation of ore bodies and the iron content in underground boreholes. Experimental results with the reflection method were compared with the chemical analyses of core samplings and were found to correlate within 3%. (L.C.L.)

Pressure

24152 IMPROVEMENTS IN OR RELATING TO RADIOACTIVE-SOURCE IONIZATION PRESSURE GAGES. Boiziau, Claude (to CEA). British Patent 1,066,687. Apr. 26, 1967. Priority date Aug. 6, 1964, France.

A radioactive ionization-pressure gage for measuring pressures from 0.75×10^3 to 0.75×10^{-4} mm Hg is described. The gage consists of an enclosure, an ionization chamber, a Pu source, and associated electronic equipment. The gas, the pressure of which is to be measured, is admitted to the enclosure. Alpha particles emitted by the source ionize the gas. An ionization chamber measures the number of ionized particles which are directly proportional to the gas pressure. (F.S.)

Radiography

39153 NEUTRON RADIOGRAPHY AND MICRORADIOGRAPHY STUDIES. Fahmy, A. A. (American Univ., Cairo). pp 537-51 of Interaction of Radiation with Solids. Bishay, Adli (ed.). New York, Plenum Press, 1967.

From Solid State Conference on Interaction of Radiation with Solids, Cairo, Sept. 3-7, 1966. See CONF-660923.

The technique of neutron radiography and microradiography depends on the attenuation of neutron beams by matter. The similarities and differences between this technique and x- and gamma-ray radiography are pointed out. The physical principles on which the technique is based are discussed, and the different methods of obtaining the radiograph are described and compared. Resolution pieces were made and used to ascertain the resolution of which the radiographic method is capable, independent of the nature of the object. Specimens of boron, a composite material of B_4C in an aluminum matrix, in the cast and rolled conditions were radiographed with x rays and neutrons and the radiographs compared. By setting up conditions for high resolution and using an extremely fine-grained film, it was possible to obtain neutron radiographs capable of 100x magnification, revealing microstructural features of the alloy. The technique is evaluated and found to be useful and practical in certain circumstances. (auth)

41169 (ORNL-tr-1780) EARLY DEVELOPMENTS OF NEUTRON RADIOGRAPHY IN FRANCE. Barton, J. P.; Boutaine, J. L. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Bull. Inform. Appl. Ind. Radioelem., No. 66, 4-9 (1967). 11p. Dep. CFSTI. JOL \$1.80 fs, \$0.80 mf.

The development of a technique using neutrons for radiography has been going on in France for two years, and the procedures are being routinely applied and undergoing long-term studies in several laboratories. Some simple aspects of the technique, in particular the use of a collimated thermal-neutron beam from a nuclear reactor, may be a good method for examination and as a basis for application in various fields of industry. Advantages of neutron radiography compared with x radiography are discussed. (M.C.G.)

41222 GAMMA DEFECTOSCOPE BETON FOR RADIOGRAPHIC STUDIES OF BUILDING CONSTRUCTIONS. Sul'kin, A. G.; Guslits, V. M.; Maiorov, A. N. Defektoskopiya, No. 3, 76-81 (1967). (In Russian).

A new specialized gamma detector for the radiography of building constructions was described. The principal fabrication and operation parameters of the defectoscope are reported and some of its radiographic possibilities are indicated. (tr-auth)

41171 NONDESTRUCTIVE TESTING OF BRAZED JOINTS. Kanno, Akira (Ship Research Inst., Tokyo). Sempaku Gijutsu Kenkyujo, No. 8, 1-23 (Nov. 1965).

The nondestructive testing of brazed joints was studied. The base metal used was ASTM 304 stainless steel. Brazing alloys containing thermal neutron-sensitive elements (boron, silver, cadmium, etc.) were chosen. As standard brazing faults, the brazing alloy foils which varied in thickness from 0.0127 to 0.0762, containing various holes, were sandwiched between the base metals which varied in thickness from 1.59 to 6.35 mm. The specimens were tested by neutron radiography, indium transfer neutron radiography, and X-radiography. The diameter and width of brazed joint faults were compared by means of the hole-type radiographic penetrometer; the relation between the hole diameter and width was in accordance with Criscuolo's equation for the thickness between 0.0254 to 0.0762 mm in X-ray radiography, in the In transfer method. The neutron radiography showed excellent detection when used on the Easy Flow brazing alloy. The In transfer method gave results comparable with X-radiographs for detection of the Easy Flow faults. Both the neutron methods gave poor results for foils which contained no neutron-sensitive elements except silver. The ultrasonic methods are advantageous in detecting nonbonds in diffusion-bonded samples, not replaceable by radiography. However, small faults of about 1.6 mm diameter cannot be shown clearly in 12.7 mm-thick specimens, especially near the edges. For the faults, the neutron radiography method is recommended for thermal neutron-sensitive brazing alloys. (NSA of Japan)

Tracers

34955 (EURAC-1863) SPECIFIC SURFACE MEASUREMENTS OF SINTERED UO_2 SAMPLES BY THE BET METHOD USING ^{133}Xe . Special Report No. 2, R/505. Giarda, L.; Knapik, P. (comps.) (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Apr. 1967. Contract 043/65 TEE(RD). 63p. (EUR-3367). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Specific surface measurements were performed on UO_2 of different densities by the BET method; the pressure was measured by recording the radioactivity of ^{133}Xe . The values obtained were in the range 0.85 to 2.2 cm^2/g for theoretical densities of 92% and 2.0 to 6.7 cm^2/g for theoretical densities of 95%. (auth)

33000 EFFICIENCY OF REFINING OF ACETIC ACID FROM INORGANIC IMPURITIES BY NORMAL FREEZING METHOD BY RADIOISOTOPIC TECHNIQUE. Knypl, E. T. (Chemical Works Oswiecim, Poland). Isotopenpraxis, 3: 190-2 (May 1967).

Investigations on the efficiency of refining of acetic acid by the normal freezing method using radiotracer technique and neutron activation are presented. The equilibrium distribution coefficient for Zn^{2+} in CH_3COOH was determined; the same coefficient was also determined for Cl^- but with a lower degree of approximation and a "generalized" distribution coefficient for a set of ions was estimated by comparison of radioactivity of original and refined samples of acetic acid after neutron activation in nuclear reactor. (auth)

39138 AUTORADIOGRAPHY AS APPLIED FOR DETERMINING THE SHAPE OF THE SOLIDIFICATION FRONT IN SEMI-CONTINUOUS ALUMINIUM CASTING. Akerman, K.; Braffman, M.; Kruszewska, O.; Kruszewski, K. (Inst. for Nuclear Research, Warsaw). Isotopenpraxis, 3: 211-17 (June 1967). (In German).

An autoradiographic technique for determining the shape of the solidification front of molten aluminium as a function of the dimensions of the aluminium and the conditions of operation has been developed. At the end of casting ^{65}Zn is added to the fused metal the microdistribution of which on the liquid-solid interface makes possible determining the shape of the solidification front by autoradiography. The method developed can be employed when the optimal characteristics of the continuous casting technique are to be determined as a function of the dimensions of the aluminium bar and its metallic composition. (tr-auth)

40830 SOME REMARKS ON THE METHODICS OF APPLYING A RADIOACTIVE SOURCE FOR MEASURING THE INTERFACIAL POTENTIAL. Kamienski, B.; Kulawik, I.; Kulawik, J.; Mikulski, J.; Pawelek, J. (Inst. of Physical Chemistry, Polish Academy of Science, Krakow. Jagiellonian Univ., Krakow. Inst. of Nuclear Physics, Polish Academy of Sciences, Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 15: 249-52 (1967).

Studies were made on the use of ^{239}Pu electrode for measuring interfacial potentials. A preparation of plutonium oxide was embedded in a 15 mm layer of resin and its activity attained 1 μC . The air resistance between the radioactive source and the free surface of a solution was measured as the function of their mutual distance. The air resistance decreased sharply as the distance between the surface and the electrode was increased, passed through a minimum and then gradually rose. The minimum value occurred at a distance of 15 to 20 mm. In addition to its being indifferent to the vapors and gases present in the laboratory, the ^{239}Pu electrode did not require any special treatment after having been accidentally wetted with the investigated solution, and its potential remained constant. (P.C.H.)

40831 APPLICATION OF A ^{239}Pu ELECTRODE FOR THE DETERMINATION OF INTERFACIAL ELECTRIC POTENTIALS. Kamienski, B.; Kulawik, I.; Kulawik, J.; Mikulski, J.; Pawelek, J. (Inst. of Physical Chemistry, Polish Academy of Science, Krakow. Jagiellonian Univ., Krakow. Inst. of Nuclear Physics, Polish Academy of Sciences, Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 15: 253-56 (1967).

Distribution potentials at the water-organic interface were measured in the system: $Hg/Hg_2Cl_2, 1 N KCl$ aqueous solution of electrolyte M^+X^- /organic phase/air/Ag. A special vessel was constructed which allowed the surface of the organic liquid to be renewed and thus contaminations and accidental charges to be removed. A radioactive ^{239}Pu electrode was suspended about 15 mm above the fresh surface of the organic phase. The activity of the electrode was about 1 μC . Ionic distribution potentials $\Delta\psi_M/N$ across the water-nitrobenzene interface at 25°C were computed from the equation containing the measured EMF values: $\Delta\psi_M/N = E_{MX} - E_{NX}$ where E_{MX} denotes the EMF of the system containing the dissolved MX compound in both phases (aqueous and organic), and E_{NX} is the EMF of the system containing the NX compound dissolved in both phases. Data are tabulated. (P.C.H.)

Atmosphere

43065 USE OF RADIOACTIVE TRACERS IN STUDYING MASS TRANSFER IN THE ATMOSPHERIC BOUNDARY LAYER. Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Munn, R. E. Phys. Fluids, Suppl., S263-6 (1967).

Natural surfaces such as snow act as almost perfect sinks for radioactive gases. Experiments are described in which tracers of differing molecular diffusivities are released simultaneously permitting interferences to be drawn about the function of the lowest few millimeters of the atmosphere in regulating vertical fluxes. The results of tracer field experiments at Chalk River, Canada, are described, and the implications are discussed. (auth)

36150 (AEC-tr-6711) RADIOACTIVE ISOTOPES IN THE ATMOSPHERE AND THEIR USE IN METEOROLOGY. Conference on Nuclear Meteorology, Obninsk, 3-6 February 1964. Karol', I. L.; Kirichenko, L. V.; Krasnopevtsev, Yu. V.; Kurganskaya, V. M.; Malakhov, S. G.; Sereda, G. A.; Yagodovskii, I. V. (eds.). Translation of Radioaktiv. Izotopy Atmos. Ispol'z. Meteorol., Nauch. Konf. Yad. Meteorol., Obninsk, 3-6 February 1964, 1-491 (1965). 374p. (PST-Cat.-1801; CONF-640208). CFSTI.

A total of 45 papers were presented at the conference. These papers were abstracted in NSA Vol. 20 issue 10. (J.R.D.)

43066 EVALUATION OF THE METHODS FOR DETERMINING THE RADIOACTIVE POLLUTION OF THE ATMOSPHERE BASED ON VARIOUS FILTRATION TECHNIQUES. Piatkowski, Adam. Warsaw, Warsaw Polytechnic Inst., 1965. (In Polish). Thesis.

A discussion of the general state of research in the field of radioactive atmospheric pollution and the physical aspects of filtration through filter paper is presented. Some of the known methods of measuring the radioactivity of air are described. Electrofilters made at the Department of Radiology and the conclusions drawn from investigations on the efficiency of electrofilter filtration as a function of the air flow rate, current intensity in corona discharge, voltage, and the shape of voltage characteristic are discussed. A method of determining radioactive pollution of air, including the measuring apparatus, experimental data obtained using the method and a discussion of the method and the results are given. (JPRS)

Flow and Leak Testing

34500 EQUIPMENT FOR INSTANTANEOUS FLOW MEASUREMENT. Wolf, R. (Electricite de France, Chateau). Houille Blanche, 21: 699-712 (1966). (In French).

Methods and instruments were developed for flow measurements. The equipment featured a radionuclide (^{137}Ba) generator directly connected to a pneumatic injector, and two detectors on the outside of the pipe connected to an electronic counter giving a direct reading of the values from which the rate of flow was derived. In developing these measurement methods, use was made mainly of such medium-period radionuclides as ^{131}I , ^{82}Br , and ^{24}Na , with the following main purposes in view: to find applications for short pipes (i.e., up to 80 dia), experimental confirmation of mathematical approaches, and design and development of equipment for everyday use. The ^{137}Ba generator which was developed represented a new approach to the measurement of pipe flow by injection of radioactive salts. It relied on the natural $^{137}\text{Cs} - ^{137}\text{Ba}$ relation with the parent ^{137}Cs being fixed to a highly selective ion-exchange resin. Washing this resin in water carried away the ^{137}Ba bred from the ^{137}Cs without moving the latter. As ^{137}Ba has a half-life of about 2.5 min, much higher radioactivity can now be fed into the pipe, for 100 min later it is reduced to only 2^{-40} times its original value. This even makes repetitive closed-circuit tests feasible. To determine the rate of flow in a pipe at least 50 dia long and whose cross-sections are known, a radioactive solution was injected and the time for passing 2 specific cross-sections A and B was detected from outside the pipe. Several mathematical approaches to the measurement problems are dealt with in an appendix. It is shown that, knowing the abscissa of the temporal center of gravity of the curve corresponding to the passage of the radioactive solution, the rate of flow in the pipe can be ascertained by external observation. Deformation due to the detector filters is discussed, and estimations made of the discharge error where interpretation is based on one particular geometrical point only. The advantages, applications, and potential scope of development of the method are also discussed. (BBB)

30722 A LEAK-TEST METHOD FOR HERMETICALLY SEALED SEMICONDUCTOR DEVICES UTILIZING RADIOACTIVE GAS ^{133}Xe . Veveris, O. E.; Gunne, Kh. E.; Kolmyukova, L. F.; Pelekis, L. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 1, 19-24 (1967). (In Russian).

The equipment for immersing the metallic containers of semiconductors in the gas and the scintillation counter for gamma-radiation measuring were described. The sensitivity of this method was achieved $10^{-8} \text{ cm}^3/\text{sec}$ by using gas of specific activity 0.1 mc/cm^3 and a scintillation counter with the sensitivity threshold $3 \times 10^{-9} \text{ c}$ at the immersing time in the gas chamber 1 h with a 6-atm pressure differential. The error of the method and the efficiency of the equipment were estimated and the radiation safety for the personnel was considered. (auth)

28084 A RADIOTRACER STUDY ON FLOW PATH OF SEEPAGE IN THE COFFER DAMS AT SRISAILAM. Iya, V. K.; Krishnamurthy, K.; Aggarwal, K. S.; Rajagopalan, R. (Atomic Energy Establishment, Trombay, India). Int. J. Appl. Radiat. Isotop., 18: 349-57 (1967).

Bromine-82 as potassium bromide was used a tracer. Scintillation counters and G-M tubes, attached to long waterproof cables were used for detection of the tracer in boreholes in the structure of the dam and in the water adjacent to the dam. Some of the major points of entry of seepage and the flow path of seepage across the coffer dam were established. The utility of Iodine-131 in this type of experiment was also determined. (auth)

Hydrology and Soil

41005 COMMUNICATION ON THE GROUND WATER COMPONENT OF RIVER DISCHARGE AND ITS RELATIONSHIP TO HYDROGEOLOGY. Balek, J.; Ralkova, J. (Inst. of Hydrodynamics, Prague). J. Inst. Water Eng., 19: 486-8 (Oct. 1965).

Measurements of fallout radionuclides were made by β assay in the course of investigating a simple, approximate method of separating ground-water flow from interflow and surface runoff by utilizing the low-level radioactivity present in natural waters. The method was tested in Czechoslovakia on the experimental basin of the Volynka River (382 km^2). Measurements of low-level radioactivity in water led to the development of a method for separating surface runoff from ground-water discharge by making use of the higher radioactivity of surface runoff. The method was based on the proposition that soils adsorbed most of the radioactivity of that part of rainfall which contributed to ground-water discharge, while the radioactivity of surface runoff remained unchanged during the period of intense rainfall. As a result of nuclear explosions, rain nearly always contained fission products, and the β activity was high enough to be measured. Experiments were carried out to determine the β activity of rainfall which occurred during storms and that of the resulting flood water. Adsorption of radioisotopes by different types of soil from the experimental basin was also studied. Lab experiments included comparison of the effect of shaking soil samples with a solution of the fission products, and permitting a similar solution to percolate through a column of the same soil samples. A high adsorption of radionuclides was observed except for anionic nuclides, but the radiation from these represented less than 5% of the total radioactivity with a half life of 0.5 to 10 yr. Moreover, radiation from ^3H , which could pass through soil, was very low, and could not be detected by ordinary monitoring equipment. Radioactivities of rain and river water were estimated by direct monitoring of the liquid, using a low-level activity scintillation counter. This method of direct measurement eliminated radioactivity losses through evaporation and sublimation. (BBB)

28093 PRIMENENIE RADIOAKTIVNYKH IZOTOPOV V GIDRAVLICHESKIKH I GIDROLOGICHESKIKH ISLEDOVANIYAKH. (Uses of Radioactive Isotopes in Hydraulic and Hydrological Studies). Vartazarov, S. Ya. Moscow, Atomizdat, 1967. 185p.

Tracer studies connected with the hydraulics of natural and artificial water basins and reservoirs are systematized. Radioactive tracers have been used for resolving some problems on the transfer and disposal of radioactive waste, the dynamics of radioactive waste flow and distribution in rivers and water basins, the characteristics and structure of turbulent water flow and for calculating diffusion in streams. Tracers have also been used in studies of closed conduct hydraulics such as in hydroelectric power plants and in bed-load and suspended sludge flow analyses of rivers and basins. (R.V.J.)

32265 (IFA-MR-27) DETERMINATION OF THE UNDERGROUND WATERS FLOWING DIRECTION BY THE SINGLE WELL METHOD. Dinesou, L.; Gaspar, E.; Oncescu, M. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1967. 15p. Dep.

A tracer technique for determining the flow direction of underground water is presented. The single well method is used in which a small quantity of radioactive tracer is injected into a borehole which is crossing an aquiferous layer. The tracer is carried away by the water and contaminates the surrounding medium, which is used for detection comparisons. The maximum of the contamination is deposited in the direction of flowing current, and the measurements performed by means of Geiger-Mueller and scintillation detectors provide the means of determining the flowing direction of the underground water at the respective point. (D.C.C.)

24177 RADIOGRAPHIC METHOD FOR INVESTIGATION OF THE MOVEMENT OF SAND AND SEDIMENT IN RIVERS USING ^{32}P . Hazzaa, I. B. (Middle Eastern Regional Radioisotope Center for the Arab Countries, Cairo). *Int. J. Appl. Radiat. Isotop.*, 18: 273-8 (May 1967).

Experiments were carried out to select the best radioisotope to label sand and sediments of the Nile and the Mediterranean. The radioisotopes tried were ^{32}P , ^{51}Cr , ^{110}Ag , ^{131}I and ^{140}Ba . Radioactive phosphorus was found to be one of the best nuclides for labelling. As a pure β -emitter, its detection was efficient when performed by radiographic methods. The radiographs obtained in two experiments undertaken in one of the Nile branches in Cairo proved that the method could be applied to indicate the direction of movement of sand and sediment in rivers and seas. (UK)

34412 DETERMINATION OF THE PERMEABILITY OF SOIL STRATA BY MEANS OF A RADIOACTIVE ISOTOPE AT THE EL-BAKRA OIL FIELD. Etman, M. H. (Atomic Energy Establishment, Cairo); Varga, K. *Energ. Atomtech.*, 19: 492-3 (Oct. 1966). (In Hungarian).

The permeability of oil-storage strata in deep wells at the El-Bakra fields of the United Arab Republic was determined by means of a special tracer technique. As the highly permeable layers accept larger amounts of the radioactive liquid than the less permeable ones, when the pressure is released, backflow is observed. By means of γ logging it was found possible to determine the exact location and the rate of this backflow. The tests were carried out with 100 mCi of ^{51}Cr adsorbed on 100 g of an ion exchange resin, mixing the labeled resin in 30 m³ of seawater. The results revealed that the zone from 1001 to 1022 m has low permeability; the 1022 to 1037 m zone is completely impermeable; from 1037 to 1052 m, the zone is not perforated. The method is suitable for the detailed determination of the permeability of oil field soil strata, yielding data that may be used to increase the productivity of the field. (TTT)

22031 ISOTOPIC INDICATORS IN THE INVESTIGATION OF UNDERGROUND WATER FLOW. Krotowicz, Jerzy (Inst. of Geology, Warsaw). *Przegl. Geol.*, 15: 30-5 (Jan. 1967). (In Polish).

Several methods of investigating underground water flow by means of isotope indicators are discussed. Methods based on both radioactive and stable isotopes detected by activation analysis are listed. Principles of selection of indicators to investigate water flows, techniques applied to avoid losses caused by sorption, and techniques for the selection of appropriate indicators, and ways of detecting various indicators used during investigations are discussed. Perspectives of practical use of the individual research methods are also taken into consideration. (tr-auth)

28082 CONTRIBUTION CONCERNING THE DETERMINATION OF NATURAL GROUNDWATER FLOW VELOCITIES WITH TRACERS. Duerbaum, H.-J. *Atomkernenergie*, 12: 130-2 (Mar.-Apr. 1967). (In German).

Groundwater flow velocities determined with the aid of tracers by recording the decreasing concentration of the tracer in one borehole or the arrival of the tracer in a second hole are not identical with the natural flow velocities. They are influenced by the very existence of the hole and are always greater than the natural velocities. It has been computed how great this effect is for the two above-mentioned cases. (auth)

30539 RADIOINDIKATORNYE METODY ISSLEDOVANIYA DVIZHENIYA PODZEMNYKH VOD. (Radiotracer Methods in the Investigation of Underground Water Flow). Churaev, N. V.; Il'in, N. I. Moscow, Atomizdat, 1967. 124p.

Theoretical principles of the radiotracer method for the investigation of streams, the results of laboratory tests, and methods for the introduction of field radiotracer measurements are examined. A review is given of the work on the use of radiotracer methods in hydrogeology, hydrology, and hydrotechniques. (tr-auth)

43049 A TECHNIQUE FOR DIGITAL COMPUTER PROCESSING OF DATA FROM RADIOISOTOPE SEDIMENT TRACING STUDIES. Hartley, P. E. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). *Int. J. Appl. Radiat. Isotop.*, 18: 713-20 (Oct. 1967).

A simpler computer technique for directly producing isoactivity contour maps from data obtained from radioisotope sediment tracing experiments is described. The method is used to process sets of readings of counting rate, position and time, taken at many points which are not necessarily on a regularly spaced grid. A FORTRAN

program using this method has been written for an IBM 7040 computer and tested on results from a silt tracing experiment in Botany Bay, Australia. The technique could be adapted to radioisotope water tracing experiments and also meteorological, oceanographic and other geophysical investigations. (UK)

Highway Construction

28289 TRACER ISOTOPE CONTROL IN SUBSURFACE COMPRESSION WORK ON THE HIGHWAY. Duftschmid, K. E. (Reaktorzentrum, Seibersdorf, Austria). *Atomwirtschaft*, 12: 125-6 (Mar. 1967). (In German).

For repair work on highways, cavities occurring under the concrete were filled with bitumen forced in under pressure. By radioactive labeling of the bitumen material using ^{24}Na -labeled-naphthenate the extent and thickness of the bitumen layers introduced under the highway can be easily controlled. Optimization of this relatively expensive operation possesses considerable economic significance. (tr-auth)

28171 (SGAE-IB/IA-14/1967) LEITISOTOPENVERSUCHE ZUR KONTROLLE VON BITUMENUNTERPRESSUNGSARBEITEN AN DER AUTOBAHN. (Tracer Isotope Experiments for the Control of Bitumen Work Pressure on the Autobahn). Duftschmid, K. E. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). 1967. 11p. (In German). Dep.

On heavily traveled concrete highways, cavities below the road-surface often occur. This is caused by the rocking motion of the concrete slabs and the squeezing out of the sand foundation. In such cases bitumen is injected by grouting holes drilled through the slabs to avoid damage. A tracer method for measuring the extension, shape and thickness of such injected bitumen layers is described. The bituminous material is labeled with ^{24}Na -naphthenate dissolved in heavy oil. The gamma radiation on the road surface is measured by a portable scintillation counter which is mounted on a handcart. The method has been tested in preliminary experiments using concrete slabs of similar dimensions as on the highway (10 x 3.75 x 0.22 m). The slabs were partly coated with various layers of labeled bitumen and then turned over with a crane. By gamma-scanning on the opposite side the shape of the coats could be determined within an accuracy of approximately ± 2 cm. In the full-scale operation the radioactive tracer is mixed with the bitumen using a rotary-type boiler. A specific activity of 20 mCi/t was proved to be sufficient for measuring layers down to 1 mm thickness. The method is suitable for routine use and makes possible an accurate control of the repair work as well as considerable savings of time and material. (tr-auth)

Radiometric Analysis

45038 CORRECTION OF TITRATION AGENT CONSUMPTION WITH REFERENCE TO THE PRECIPITATION SOLUBILITY IN RADIOMETRIC AND SIMILAR TITRATIONS. Klas, J. (Technische Hochschule, Bratislava). *Collect. Czech. Chem. Commun.*, 32: 2362-5 (June 1967). (In Czech).

In the case of radiometric or similar titrations in very dilute solutions or in cases where the precipitate has a relatively high solubility product, titration agent consumption corresponding to the end point must be corrected to the equivalence point. Equations were derived for the calculation of this equivalence point. Use of the equations is illustrated. (tr-auth)

25790 THEORY OF RADIOMETRIC PRECIPITATIONAL TITRATION OF LABELED SAMPLES WITH AN INACTIVE MEASURING SOLUTION. Jesenak, V.; Veltyni, J.; Toelgyessy, J. (Slovak Technical Univ., Bratislava). *Atompraxis*, 12: 606-9 (Dec. 1966). (In German).

The relations among various parameters in radiometric precipitation titration of a labeled ion with an inactive standard solution studied at any given stoichiometry of the precipitating reaction were examined. These relations were then converted into non-dimensional equations, evaluated for variables within wide limits, and presented graphically in order to illustrate the influence of the experimental conditions. The exact evaluation of the measurement results according to the derived equation makes it possible to use precipitation reactions in which a precipitate of a relatively high solubility product is formed. A simplification of the equation for solubility products of low values facilitates evaluation of the results measured. For serial analyses, a graphical evaluation method is suggested. (auth)

38918 IMPROVED METHODS OF RADIOMETRIC ANALYSIS BASED ON THE ISOTOPIC EXCHANGE REACTION. Ikeda, Nagao; Amano, Sadayo (Tokyo Kyoiku Univ.). *Radiotopes* (Tokyo), 16: 317-22 (July 1967).

Improved methods of analysis based on application of isotopic exchange are proposed. The methods are classified as: the direct isotopic-exchange method, the reverse isotopic-exchange method, the double isotopic-exchange method, and the two-step isotopic-exchange method. The nonradioactive sample is analyzed by the first or second methods and the radioactive sample is analyzed by the second, third, or fourth methods. The principles and mathematical calculations of these methods were verified experimentally in the determination of iodide ions using the $\text{I}^-(\text{aq}) - \text{I}_2$ (in CCl_4) exchange system. (auth)

30360 ION-EXCHANGE MEMBRANES IN RADIOCHELATO-METRIC TITRATIONS OF TRACES OF METALS. Toelgyessy, J.; Konecny, J.; Braun, T. (Slovak Technical Univ., Bratislava). Nucl. Appl., 3: 383-9(June 1967).

Ion-exchange membranes can be used to separate reaction products from the initial components in radiochelato-metric titrations. Their use speeds up and simplifies the titration. By this method traces of cobalt and zinc were determined with 10^{-5} M EDTA or DCYTA solutions as titrants. (auth)

32099 RADIOACTIVE TRACER METHOD FOR DETERMINING PRASEODYMIUM IMPURITY IN CERIUM COMPOUNDS. Kostygov, A. S.; Saumkin, O. F. (State Scientific-Research and Planning Inst. of the Rare-Metals Industry, Moscow). Zavod. Lab., 33: 678-9 (1967). (In Russian).

A method is suggested for radioactive tracer control of high-purity cerium compounds during ion exchange purification of ammonium hexanitrocerate. Praseodymium impurities were determined with sensitivity up to $1 \times 10^{-8}\%$. (tr-auth)

25808 RADIOMETRIC TITRATIONS. Braun, T.; Toelgyessy, J. International Series of Monographs in Analytical Chemistry. Volume 29. New York, Pergamon Press, 1967. 177p.

Radiometric titrations based on precipitate formation, complex formation, and redox reactions are presented. (164 references). (J.G.B.)

21883 RADIOMETRIC DETERMINATION OF SUBMICROGRAM AMOUNTS OF MERCURY. Stary, Jiri (Univ., Prague); Milosevic, Radule. Talanta, 14: 521-2(Apr. 1967).

A radiometric method for the determination of submicrogram amounts of mercury (down to 5×10^{-10} g/ml) is described. The method is based on the exchange reaction between mercury and silver-110m dithizonate. Only palladium, gold, silver, and large amounts of copper and bismuth interfere in the determination, and must be removed. (auth)

21878 DETERMINATION OF ARSENIC BY THE URANYL SALT METHOD. PART II. THE RADIOMETRIC DETERMINATION OF MICROGRAM AMOUNTS OF ARSENIC BY A FILTER-SPOT TECHNIQUE. Wilson, A. D.; Lewis, D. T. (Lab. of the Government Chemist, London). Analyst, 92: 260-3(Apr. 1967).

Development of the uranyl salt method for the gravimetric determination of arsenic is described. Gravimetric manipulations are conducted on a filter paper base and the arsenic content of the ammonium uranyl arsenate precipitate is determined indirectly by measuring the alpha count-rate of the associated uranium. The method was demonstrated applicable in the range 1 to 8 μ g of arsenic. (auth)

COMMERCIAL PRODUCTS PRESERVATION

Food

24702 PROGRESS IN FOOD IRRADIATION. Ingram, M.; Rhodes, D. N. (Low Temperature Research Station, Cambridge, Eng.). Food Manuf., 37: 318-25(July 1962).

Radiopasteurization and radiopreservation of foods are reviewed. The primary limitation lies in the production of damage to the organoleptic quality, either immediate or delayed. After low dose treatments (0.01-0.1 Mrad), foods are usually indistinguishable by odor and flavor from the untreated material, although in some cases changes in color occur. Two main possibilities for low-dose treatment can be distinguished: the delay or prevention of breaking of dormancy in vegetables, and the destruction of infesting insects in stored grains and dried fruits or animal parasites in meats. With medium-dose treatments (0.1-1.0 Mrad), the main objective is the destruction of the microorganisms contaminating foods. Such treatment may result in the removal of bacteria dangerous to man or simply in the extension of storage life of perishable commodities by the general reduction of contamination. Specialized processes (1-3 Mrad), intermediate between pasteurization and sterilization treatments, aim at near but not complete sterilization in special products where a low bacterial count is desirable. High-dose treatments (~5 Mrad) usually aim to produce sterility in an otherwise perishable food, which means either the total absence of bacteria, over a large number of containers, or that the few surviving organisms are so damaged as to be unable to develop in the environment of the particular food (commercial sterility). Canned hams treated with doses of 0.6 Mrad and heated to 75° remain satisfactory in quality, while most of the bacteria are destroyed and the irradiated product is at least as stable as the corresponding heated one. Problems to be overcome in radiation processing are discussed. (TSS)

36776 BELGIAN WORK ON FOOD IRRADIATION. De Proost, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Meded. Landbouwhogeschool, Opzoekingssta. Staat Gent, 30: 667-72 (1965). (In French). (BLG-414).

Research work carried out in Belgium on the irradiation of food is reviewed. Studies on the radiopreservation of vegetables and fruit, the disinfestation of food, and the effects of γ radiation on wheat flour are described. Other studies concerning the wholesomeness of irradiated food are mentioned, and gamma irradiation facilities available in Belgium are listed. (31 references). (C.H.)

36774 (JPRS-40968) INSTALLATION FOR THE IRRADIATION OF FOOD PRODUCTS. Translated from Nauka Zhizn', 23: No. 8, 19-20(1956). 7p. (TT-67-31610). CFSTI.

The principal requirements of industrial radiosterilizers and the use of the Van de Graaff accelerator in these devices are discussed. A γ -ray sterilizer with a screw-type conveyor that can be used for prolonged irradiation of potatoes is described. (B.H.S.)

32814 PROGRESS OF FOOD IRRADIATION WORK AND PROGRAMMES IN O.E.C.D. MEMBER COUNTRIES. Food Irradiat., 7: No. 3, 2-40(Jan.-Mar. 1967).

The current status of research projects on food irradiation in O.E.C.D. member countries is described. Summaries of progress in basic research, industrial development, irradiation sources and facilities, legislation, publication, and wholesomeness testing are included. (B.H.S.)

39541 RECENT TRENDS IN IRRADIATION OF FOOD. Ley, F. J. (Atomic Energy Research Establishment, Wantage, Eng.). Chem. Brit., 3: 298-300(July 1967).

The present usage and future prospects of irradiation of food-stuffs for the purposes of preservation or disinfestation are reviewed. It is pointed out that procedure has been instituted for obtaining official approval for specific processes, in U.K. and other countries. This procedure is outlined and food products cleared for irradiation treatment are enumerated. Studies conducted at the Wantage Research Laboratory, and in America and other countries, are outlined, together with industrial implications. (UK)

28714 BELGIUM CONTRIBUTIONS TO THE DATA ON IRRADIATION OF SUBSTANCES. De Proost, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). 6p. (In French). (CONF-650581-1). DTIC.

From 2nd International Symposium on Applications of Nuclear Science in Agronomy and Veterinary Medicine, Ghent.

A brief review of the research projects in Belgium concerned with the effects of γ radiation on germination of potatoes; preservation of carrots, cherries, pears, strawberries, wheat, wheat flour, and white vegetables; metamorphic stages of the grain and rice weevils, Sitophilus granarius L. and Sitophilus oryzae L., the Mediterranean flour moth, Anagasta kuehniella, and the white bean infesting beetle, Acanthoscelides obtectus; and the sterility of white vegetables experimentally contaminated with Clostridium sporogenes is presented. Studies on the genetic risks involved in consumption of γ -irradiated foods are also briefly outlined. Descriptions of the ^{60}Co γ -irradiation facilities that were used in the projects are given. (B.H.S.)

41523 (AECL-2873) POTENTIAL ROLE OF RADIATION IN ALLEVIATING SOME WORLD FOOD PROBLEMS. MacQueen, K. F. (Atomic Energy of Canada, Ltd., Ottawa (Ontario). Commercial Products Div.). Apr. 1967. 64p. (CONF-670522-4). Dop. CFSTI. CAN \$1.50. I & RT 5(2)

From International Conference on World Review of Nuclear Reactors and Radioisotopes, Montreal, Canada.

The possibilities of using radiation processing of foods to help conserve and improve the distribution of the world's food supplies are discussed. Applications of radiation processing discussed include: the control of insect infestation of foods; the use of radiation processing to extend the storage life of tropical fruits and vegetables; the use of radiation processing to extend the storage life of fresh fish and seafoods; radiation control of Salmonellae in animal feeds; and the use of radiation as a quarantine control measure to inactivate foot and mouth virus in carcasses of infected animals. (53 references). (C.H.)

32816 THE TECHNICAL BASIS FOR LEGISLATION ON IRRADIATED FOOD. REPORT OF A JOINT FAO-IAEA-WHIO EXPERT COMMITTEE: ROME, 21-28, APRIL 1964. World Health Organ., Tech. Rep. Ser., No. 316, 1-37 (1966).

General principles governing the production and use of irradiated food are considered, along with recommendations for the establishment of legislation and control. Recommended technical procedures and tests required to permit an evaluation of the safety for consumption of irradiated food are outlined, including tests for microbiological safety. It is recommended that distribution of a specified irradiated food intended for general public consumption should be permitted only after acceptance by the appropriate government authority of evidence that the food is safe for human consumption. Legal control of irradiated food can be best accomplished by the use of a list of permitted foods irradiated under specific conditions. Irradiation of feed intended for consumption by animals should be subjected to control by procedures analogous to those used for the control of irradiated food for human consumption. An appendix is provided which furnishes information on the technology of the irradiation process, technical terms used in this report, type of information to be submitted in support of a request to irradiate a specific food intended for general distribution, detection of previous treatment by irradiation, and an example of protocols for animal feeding studies on irradiated food. (BBB)

41525 (PAEC(A)IN-671) FOOD IRRADIATION FACILITIES. A Literature Search. (Philippine Atomic Energy Commission, Manila). Mar. 1967. 23p. Dep.

One-hundred and twenty-five references are presented to literature on food irradiation facilities. (C.H.)

45840 GAS CHROMATOGRAPHIC IDENTIFICATION OF IRRADIATED FOODS. Jansson, B.; Loeferth, G. (Univ. of Stockholm). *Atompraxid*, 13: 254-6 (June 1967).

There may be needs for methods to identify whether certain foods have been irradiated or not. One of many available techniques is gas chromatography (GC) that is highly sensitive and that can easily be standardized. It is shown that egg powder irradiated as to simulate industrial application can be distinguished easily from unirradiated egg powder by GC. A similar separation of flour prepared from irradiated and unirradiated wheat seeds was not possible but may become possible after technical improvement. (auth)

24704 RADIATION PRESERVATION. Hansen, Poul-Ivar E. (Danish Meat Research Inst., Roskilde, Denmark). *Medlemsbl. Dan. Dyrslaegerfor.*, 49: 120-6 (Feb. 1, 1966). (In Danish).

A review is given of the use of ionizing radiations for food pasteurization and sterilization. The relative advantages of γ radiation, usually from ^{60}Co , and electron beam radiation for sterilization of various products are compared. Electrons are of limited value for bulk material, since maximum penetration (approx. 0.5 cm/MeV) and effective penetration (0.35 cm/MeV) are relatively low when contrasted with ^{60}Co γ rays. Doses required vary from 50,000 rads to eliminate insects in stored grain to 1 Mrads or more to inactivate bacterial spores. In most foods so far tested, sterilizing doses of 4 to 5 Mrads have produced objectionable odors and flavors in the irradiated products, whereas such changes are usually minimal or absent with pasteurizing doses (0.1 to 1 Mrad). Problems of acceptability of irradiated foods from a safety viewpoint are also considered, and regulations introduced in the United States, Canada, and the USSR which allow bacon, potatoes, and a few other products to be irradiated for consumer use are discussed. A table shows the various food products which have so far been examined as candidates for radiation preservation, showing doses used and effects produced. The program for potato irradiation, to prevent sprouting, being conducted in Greenland is described. (BBB)

Wholesomeness

22835 MUTAGENIC ACTIVITY OF IRRADIATED FOOD CONSTITUENTS. Khan, A. H. (Cambridge Univ., Eng.). *Nucleus* (Lahore), 3: No. 1-2, 30-1 (Jan.-June 1966).

Experiments designed to detect a mutagenic effect of DNA towards *Drosophila* larvae after the DNA was exposed to a heavy dose of ionizing radiation prior to its addition to a chemically defined and axenic *Drosophila* medium are described. Although non-irradiated DNA is found to be mutagenic under these conditions, the prior irradiation of the DNA does not change the mutagenic effectiveness of the DNA compared with the non-irradiated DNA sample. (auth)

43548 LONG-TERM EFFECTS OF FEEDING IRRADIATED ONION TO DOGS. Hilliard, W. G.; Oliver, W. T.; Van Petten, G. R. (Univ. of Guelph, Can.). *Food Cosmet. Toxicol.*, 4: 577-83 (Dec. 1966).

Clinical, hematological, and pathological observations were made during an 18-month trial in which γ -irradiated or nonirradiated onion was incorporated in the daily diet of beagle dogs to determine whether irradiation imparts toxicity. The dogs received the basic ration containing the equivalent of 25% wet wt onion treated with 20 KRAD of ^{60}Co γ rays. Irradiated onion in the diet produced no clinical or gross pathological changes. A slight degree of anemia was consistently found together with

moderate degenerative changes of testes and ovaries in the onion-fed dogs, but these changes could not be related to the irradiation of the onion. No evidence was obtained to indicate that irradiation changed the characteristics of onion so as to induce toxicity. (BBB)

43545 EFFECT OF FEEDING IRRADIATED ONION TO CONSECUTIVE GENERATIONS OF THE RAT. Van Petten, G. R.; Hilliard, W. G.; Oliver, W. T. (Univ. of Guelph, Can.). *Food Cosmet. Toxicol.*, 4: 593-9 (Dec. 1966).

A study was designed to determine whether one-yr feeding of γ -irradiated or nonirradiated onion to consecutive generations of rats would reveal toxic effects not apparent in a previous report. Eighteen second-generation rats of each sex were selected from each of the seven groups used in the previous study and maintained to 26 weeks of age on the same diets as their parents. Third-generation rats were similarly maintained to six weeks of age. Although certain isolated changes in hematology were found during the experiment, extensive analysis of the hematological and pathological data obtained terminally indicated no significant difference between the groups in either generation. It was concluded, therefore, that the feeding of irradiated onion, in amounts considerably in excess of predicted human consumption to two successive generations of rats produces no toxic effect. (BBB)

24694 (JPRS-40232) EFFECT OF GAMMA IRRADIATED PLANT FOOD ON MONKEYS. Okuneva, L. A.; Shillinger, Yu. I.; Maganova, N. B. Translated from *Vop. Pitan.*, 25: No. 3, 52-8 (1966). 9p. (TT-67-30878). CFSSTI.

A diet consisting of ^{60}Co γ -irradiated dried and fresh fruits, vegetables, and bread from irradiated wheat was fed to nine macaca-rhesus monkeys. The test group consisted of one male and four females; one female had a four-month-old infant. The control group consisted of one male and three females. The monkeys were fed three times a day with the test diet for 11 months. During the period of observation the female monkeys in both groups either became pregnant or bore an offspring. Results showed that the test monkeys did not differ significantly in development of offspring or in general conditions of health. Blood morphology indicators and levels of cholesterol, lipoproteins and protein in the blood were all well within normal limits. (B.H.S.)

43549 EFFECTS OF FEEDING IRRADIATED ONION TO RATS AND PIGS. Oliver, W. T.; Hilliard, W. G.; Van Petten, G. R. (Univ. of Guelph, Can.). *Food Cosmet. Toxicol.*, 4: 569-76 (Dec. 1966).

Rats and swine were maintained for 12 and 24 weeks respectively on diets containing nonirradiated or γ -irradiated onion. During this time they were examined clinically and hematologically. Blood samples were collected for biochemical analyses, the animals were autopsied, and tissues submitted to histopathological examinations. The onion was treated with 20.3 KRAD of ^{60}Co radiation. Eight Yorkshire breed pigs, eight weeks old, were maintained on diets containing the equivalent of 25% wet weight of irradiated or nonirradiated onions. Also, 30 male and 30 female four week old Wistar rats were fed similarly. Food consumption, weight gain, pathology, and clinical condition of animals were not changed significantly by inclusion of irradiated onion in the diet. However, hemoglobin levels of control swine and test rats, hematocrit levels in male control swine, and total erythrocyte count in test rats showed statistically significant decreases. These and other discrepancies indicated that more detailed studies of additional species over longer periods of time are required to define the toxicity of irradiated onion. (BBB)

30947 ON THE ARTIFICIAL RADIOACTIVITY ORIGINATED IN FOODS BY IRRADIATION IN THE ENERGY RANGE GREATER THAN 10 MeV. Tuchscheerer, Th. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). *Atomkernenergie*, 12: 71-80 (Jan.-Feb. 1967). (In German).

A simple theoretical method for the determination of induced radioactivity in foods irradiated with high energy linacs ($E > 10$ MeV) is described. Only the (γ, n) reaction is considered. The calculated activity values using nonrelativistic Sommerfeld bremsstrahlung theory are confirmed by experiments. The high energy radiation used resulted from the $^7\text{Li}(p, \gamma)^8\text{Be}$ -resonance. Induced activity is compared with natural activity of foods and the quantity of ^{90}Sr fallout. (auth)

Grains

34850 RESEARCH CONCERNING THE INFLUENCE OF IONIZING RADIATIONS ON THE KEEPING QUALITY OF SUGAR BEETS. Stătescu, P.; Marseu, P.; Costache, A.; Zamfirescu, M.; Diaconu, T. (Institutul de Cercetari Alimentare, Bucharest). Ind. Aliment., 16: 575-8 (Nov. 1965). (In Rumanian).

Attempts were made to prolong the storage time of sugar beet roots by γ irradiation. Doses of 5000, 8000, 10000, and 12000 R were used; beets were stored at 6 to 8°C. Tests were made of the rate of germination, weight changes, and sugar content of irradiated and control beets. Germination was not inhibited entirely by any of the doses used. After a storage period of 125 days the weight loss was 15 to 100% lower after the 5000- and 8000-R doses than that of unirradiated beets. With the same doses the decreases in sugar content were 34.0 to 85.7% less than in control samples. However, sugar content of the beets was lower in the samples receiving 10000 and 12000 R than in the controls. The invert sugar content increased with increasing radiation doses. The quality of the juice of the beets was considered to be greater in the irradiated material. (BBB)

24701 EFFECT OF IRRADIATION ON STORAGE QUALITY OF POTATOES. Sawyer, R. L.; Dallyn, S. L. (Long Island Vegetable Research Farm, Riverhead, N. Y.). Amer. Potato J., 38: 227-35 (June 1961).

Studies on six varieties of potatoes were conducted with γ radiation and fast electrons to determine the levels of irradiation that would give satisfactory commercial control of sprouting without detrimental side effects such as rot and the various darkening discolorations associated with the potato tuber. Sprouting in Green Mountain and Katahdin varieties was inhibited at lower doses of irradiation more so than in other varieties tested. Doses of 5000 to 7000 R gave good commercial control with Green Mountain and Katahdin, whereas, considerable sprouting was still evidenced at 10,000 R with Cobbler, Russet Burbank, and Kennebec varieties. Commercial control of sprouting, for long-term periods, could be obtained with most important potato varieties at radiation doses of 7500 to 12,500 R. Storage rot was increased by irradiation; usually this was not encountered at the levels of irradiation necessary for commercial control of sprouting. Black spot of potatoes was increased by irradiation at levels necessary for commercial control of sprouting with most varieties tested. After cooking, darkening of potatoes was increased by treatment at levels necessary for commercial control of sprouting with most varieties tested. Irradiation at 12,500 R caused a reduction in both normal and wound periderm formation. (BBB)

24703 CONTROL OF INSECTS IN STORED GRAIN BY IRRADIATION. Cornwell, P. B. (Roentokil Labs. Ltd., East Grinstead, Eng.). Proc. Int. Food Ind. Congr., London, 1964, 205-5 (Publ. 1965).

A review of the present state of knowledge and the steps being taken to encourage the application of ionizing radiations for disinfection of grain is given. The grain is treated in motion, passing through a shield housing the source or machine that delivers the required dose of radiation. Consideration of the physical properties of γ and electron radiations suggest that grain should be treated during gravity fall. The dose level for grain disinfection (16,000 rads) does not adversely affect the milling, baking or organoleptic properties of wheat, nor does several times this dose. There is no loss in nutritional adequacy and there is no induced toxicity. The minimum annual throughput of grain which can be treated economically by irradiation is about 200,000 tons. The operating costs are competitive with those for conventional measures of insect control. The reliability of ^{60}Co plant and electron machines under conditions of commercial grain handling would require pilot operation for evaluation. (TSS)

22829 (AECD-RB-2) SURVEY AND RADIO-STERILIZATION DOSES OF FUNGI CAUSING SPOILAGE OF RICE IN STORAGE. Chowdhury, S. U.; Hossain, M. M.; Yusuf, Q. M. (Atomic Energy Centre, Dacca (Pakistan). Radiobiology Div.). May 1966. 36p. Dep. mn.

Six different species of fungi were found to be responsible for the spoilage of stored rice. These included *Mucor fragilis*, *Aspergillus ochraceus*, *A. ustus*, *A. tamarii*, *A. versicolor*, and *Rhizopus oryzae*. Gamma radiation, from a ^{60}Co source, at doses of 192 to 225 Kr sterilized the rice, while doses of 170 to 185 Kr inactivated the fungi and prevented spoilage of stored rice. (C.H.)

24492 (AECD-RB-5) A REVIEW ON PROBLEMS ASSOCIATED WITH PRESERVATION OF STORED RICE IN PAKISTAN. Matin, Abdul; Amin, Ruhul; Hamid, M. A. (Atomic Energy Centre, Dacca (Pakistan)). Dec. 1966. 28p. Dep.

Problems associated with the storage of rice are reviewed. Application of γ radiation processing for the eradication of fungi and insects causing spoilage of stored rice are discussed. Insects infesting rice were killed by exposure to a dose of 16 Krad γ radiation. Results are presented from preliminary studies on the effects of various doses of γ radiation on the color, flavor, odor, taste, and texture of rice exposed both before and after the husk was removed and before and after the rice was parboiled. (C.H.)

32815 IRRADIATION OF POTATOES IN PAKISTAN. Farooqi, W. A.; Mchuyuddin, M.; Hamid, M. A. (Atomic Energy Centre, Lahore). Food Irradiat., 7: No. 3, 41-4 (Jan.-Mar. 1967).

Potatoes of the Ultimus Holland variety were γ -irradiated in bulk at 2 to 10 krad and then stored at 83°F and 69% relative humidity. Results on the effects of radiation on sprout length, incidence of storage rot, and weight loss due to storage and sprouting are presented in tabular form. It was concluded that with the increase of the radiation dose, loss of water content and the incidence of storage rot was greatly reduced. The radiation dose of 2 krad showed a stimulation effect on sprouting. (B.H.S.)

28708 SOME EFFECTS OF GAMMA RADIATION ON SEVERAL VARIETIES OF TASMANIAN POTATOES. II. BIOCHEMICAL CHANGES. Wills, Pamela A. Austral. J. Exper. Agr. Animal Husbandry, 5: 289-95 (1965).

Tasmanian Up-to-date, Kennebec, Sebago, and Sequoia tubers were treated with low doses of gamma radiation to inhibit sprouting and were subsequently stored at 68°F or 45°F. Tubers were examined at bi-monthly intervals for some, or all, of the following biochemical constituents: dry matter, thiamine, reduced ascorbic acid, dehydroascorbic acid, total ascorbic acid, soluble reducing sugars, sucrose, total sugars, and starch. Radiation, independent of dose level, led to lower dry matter contents in the Up-to-date, Kennebec, and Sequoia tubers after four months storage, and in the Sebago tubers after six months storage at 68°F, but not at 45°F, when compared to the controls. The thiamine content of Up-to-date tubers was not influenced by radiation (16,000 R). Storage was a more important factor than radiation in altering the ascorbic acid content of tubers. Radiation maintained, or even increased the normal level. Radiation increased the soluble reducing sugar content of Sequoia tubers, the total sugar of Sequoia and Sebago tubers, and the sucrose content of the Sebago tubers, but had little effect on the starch content of these varieties. Storage influenced some of these constituents, particularly in the Sebago variety. (auth)

32329 (NP-16757) ECONOMIC FEASIBILITY OF THE USE OF LARGE RADIATION SOURCES FOR THE PRESERVATION OF POTATOES AND ONIONS. Cohen, Yigal (Economic Consulting and Planning Ltd., Tel Aviv (Israel)). Mar. 1967. 136p. Dep.

For Israel Atomic Energy Commission, YAVNE. Sureq Nuclear Research Center.

An economic feasibility study of radiation preservation of potatoes and onions is presented. The comparisons of cold-storage, chemical retardation, and irradiation methods of preservation are discussed. (D.C.C.)

Fruits and Vegetables

41528 IRRADIATION OF FRUIT. EXPERIMENTAL FACILITIES AND BIOCHEMICAL STUDIES. Romani, R. J.; Bowers, J. B. (Univ. of California, Davis). Contract AT(11-1)-34. pp 357-62 of XVth Intern. Hort. Congr., Brussels, Aug. 31 to Sept. 8, 1962. Gembloux, Belgium, Editions J. Duculot.

A description is given of a 32,500-Ci ^{60}Co source used for studying effects of ionizing radiation of developmental processes in fruit, and some preliminary results obtained with it. Respiration (CO_2 evolution) rates were determined for some irradiated fruit. Respiration of pears irradiated at two different stages of the climacteric is reported. Irradiation at or near the climacteric peak results in a relatively low respiration response and little manifestation of other irradiation effects such as delayed loss of chlorophyll and decreased rate of softening. By attaching air lines to the irradiation chamber it was possible to measure the respiratory response during irradiation and thus obtain a continuous measure of respiration. Such a respiratory pattern for lemon fruit is shown, revealing differences in respiration response with increasing radiation dose. Although the immediate respiration increase following 50 Krad exposure (10 min) was nominal, there followed a continual rise indicating a definite physiological effect. A difference was apparent between 100 and 200 Krad treatments and the response at 400 and 800 Krad. Respiration during irradiation increased steadily to a point between 200 and 400 Krad where it reached a plateau. Lemons receiving a dose treatment below this plateau (100 and 200 Krad) exhibited an initial burst of respiration which then continued at an elevated level for six hr with only a slight increase in respiration after irradiation followed by a continual rate of decline. After 24 hr, the fruit irradiated at the higher doses had lower rates of respiration than that having received 100 or 200 Krad. Evidently these lemons received a critical amount of irradiation injury somewhere between 200 and 400 Krad. This dose range was also found to encompass the critical limits for irradiation to prolong storage life. At the lower radiation doses the continued high post-irradiation respiratory level was interpreted as an injury response, with the repair mechanisms accounting for an increased metabolism. At the higher doses sufficient damage was caused to the respiratory mechanisms that cellular repair could not take place, resulting in a rapidly declining respiration rate and cell death. Some short-term postirradiation effects in lemons as reflected by changes in the extracted juice are also reported. (BBB)

41518 STUDIES OF THE VITAMIN C CONTENT OF SOME CULTIVATED PLANTS AFTER CHRONIC AND ACUTE γ IRRADIATION. Hosek, K.; Pleticha-Lansky, R.; Hodova, H. (Inst. of Experimental Botany, Prague). Abh. Deut. Akad. Wiss. Berlin, Kl. Med., No. 4 379-83(1966).

From Symposium on Electrical Methods and Principles in Molecular Biology, Jena, Ger., May 25-29, 1965. See CONF-650556.

Preliminary results are reported from studies on the effects of γ rays on tomatoes and red peppers. The plants were chronically irradiated in the gamma field using doses of 0.5 to 1.4×10^5 R over the vegetative period (927 hrs). Polarographic estimation of the l-ascorbic acid content showed that under these irradiation conditions no vitamin was destroyed. Therefore the mechanisms of the biosynthesis of ascorbic acid remained unaffected. Normal formation of this vitamin can be assumed in individual plants selected for further breeding. Acute γ irradiation (2.0 to 3.5×10^4 R) of tomato seeds caused a decrease of ascorbic acid content in the first generation. (auth)

39524 (NP-16897) REPORT ON YEAST STRAINS PRESENT IN THE DIFFERENT FRUIT JUICES AND THE PROBLEM OF THEIR RESISTANCE TO IONISING RADIATIONS. Dupuy, P.; Mouton, R. (Institut National de la Recherche Agronomique, Versailles (France)). May 1965. 9p.

Yeasts were found to be the most radiation-resistant microorganisms contaminating fruit juices. In order to develop radiation processing methods for fruit juices, a program to determine radiation resistance of the most resistant species of yeasts is proposed. Among the following genera, several species are suggested for investigation: *Candida*, *Cryptococcus*, *Kloeckera*, *Rhodotorula*, *Torulopsis*, and *Trigonopsis*. (W.E.B.)

43544 IRRADIATION OF MANGOES. I. RADIATION-INDUCED DELAY IN RIPENING OF ALPHONSO MANGOES. Dharkar, S. D.; Savagaon, K. A.; Srirangarajan, A. N.; Sreenivasan, A. (Atomic Energy Establishment Trombay, Bombay). J. Food Sci., 31: 863-9(Nov.-Dec. 1966).

Mangoes (*Mangifera indica*) were irradiated in various atmospheres with ^{60}Co at a dose rate of 25 Krad/min to doses of 12, 25, 50, 75, 100, and 200 Krad. Extension of storage life of unripe and mature Alphonso mangoes was achieved at an optimum dose of 25 Krad when irradiated under air, nitrogen, or carbon dioxide. Nitrogen atmosphere during irradiation was advantageous in minimizing changes in organoleptic quality, ascorbic acid, and carotenoids, and at the same time allowed the least spoilage of fruit. Judging from skin color and fruit firmness, a six day delay in ripening could be expected in fruits irradiated with 25 Krad under nitrogen or air. Radiation effects on fruit skin were more prominent in terms of inhibition in chlorophyll disappearance and carotenoid formation than in ripening changes in the fruit. Changes in acidity, total and reducing sugars, and starch during ripening of control and irradiated mangoes are reported. A delayed reduction in acidity under the stress of irradiation was seen. Reducing sugars were increased in the irradiated mangoes, although some delay was observed in total sugar formation and starch disappearance. Changes in skin color were not correlated well with the stage of ripening of irradiated mangoes, since fruits at an eating-ripe stage still had green skin. Radiation effects on fruit skin were manifested more prominently in terms of inhibition in chlorophyll disappearance and carotenoid formation than in the ripening changes in the meat of the fruit. The higher fruit pressure of irradiated mangoes, with green skin but ripe meat, was reflected by the hardness of the skin. (BBB)

41527 IRRADIATION OF MANGOES. II. RADIATION EFFECTS ON SKIN-COATED ALPHONSO MANGOES. Dharkar, S. D.; Savagaon, K. A.; Srirangarajan, A. N.; Sreenivasan, A. (Atomic Energy Establishment Trombay, Bombay). J. Food Sci., 31: 870-7(Nov.-Dec. 1966).

The combined effects of radiation and skin-coating on storage life, organoleptic qualities, and control of respiration in mangoes were studied. The mangoes were irradiated under gaseous atmospheres of air, nitrogen, or carbon dioxide. The skins were coated with an emulsion of an acetylated monoglyceride. Skin-coated fruits showed physiological damage presumably due to inhibition of respiration. This defect was rectified by a spurt in respiratory activity when fruits were irradiated in air or nitrogen. Irradiation in carbon dioxide, that also retarded respiration, caused physiological damage that was reversible, the recovery of organoleptic qualities occurring to some extent. Suppression of respiration beyond an optimum level was responsible for irreversible damage to the fruit. Organoleptic evaluation, analysis for fruit constituents, skin color, and pressure tests showed that storage life of the fruit could be increased by combining skin-coating with irradiation under either air or nitrogen. (BBB)

43546 EFFECTS OF DEVELOPMENTAL STAGE AT THE TIME OF GAMMA IRRADIATION AND TREATMENT WITH INDOLYL-3-ACETIC ACID ON THE STORAGE BEHAVIOUR OF TOMATOES. Mathur, P. B. (Central Food Technological Research Inst., Mysore, India). Int. J. Appl. Radiat. Isotop., 18: 663-5(Sept. 1967).

Studies are described with a view to determining (i) the maximum gamma dose which would not interfere with natural ripening, (ii) the best developmental stage, particularly in relation to the respiratory "climacteric," for irradiation, and (iii) the effect of treatment with indolyl-3-acetic acid to reduce susceptibility to decay of the irradiated fruit. The optimum ^{60}Co gamma ray dose was found to be 75 kR, for subsequent storage at 9° to 10°C and relative humidity 85 to 90%. A dose of 100 kR adversely affected ripening, although decay was controlled. Treatment with the methyl ester of indolyl-3-acetic acid was carried out by dipping the fruits in a 500 ppm solution for 50 mins. Data are tabulated. Irradiation soon after picking resulted in hastening of ripening and decrease in storage life at room temperature. Irradiation at the respiratory pre-climacteric minimum slowed ripening and resulted in increased storage life. Treatment with the hormone resulted in a further slowing of ripening and a further increase of storage life. Data are also given for storage at 9° to 10°C , this representing the optimum storage temperature. (UK)

28672 EFFECTS OF ^{60}Co GAMMA RAYS ON RESPIRATION RATE, LOSS IN WEIGHT, AND APPEARANCE OF GREEN AND RIPE SHAMOUTI ORANGE FRUITS. Kahan, R. S. (Israel Atomic Energy Commission, Yavne); Aharoni, Y.; Lattar, F. S. *Israel J. Agr. Res.*, 15: 201-7 (Oct. 1965).

Shamouti oranges were γ irradiated at a dose rate of 400 Krad/hr to test the effects on the respiration rate of the fruit, loss in weight, and color changes in the skin of near-ripe green oranges. The effects of radiation on freshly picked, ripe fruit and on fruit stored for one month prior to irradiation were also compared. Green oranges irradiated with 21 to 175 Krad suffered severe skin damage and natural degreening was retarded. Doses of 63 Krad did not cause any skin damage to ripe fruit. There were no textural or other macroscopic changes in the pulp of either green-skinned or ripe oranges. Irradiation brought about a several-fold increase in the respiration rate of freshly picked fruit, both green and ripe; the increase was much smaller in fruit stored for 1 month before irradiation. The maximum increase occurred during the first 2 days after irradiation, but the rates of increase were not proportional to the radiation dose. Irradiation of freshly picked oranges resulted in increased loss of weight in storage. This increase apparently depended on the interval between picking and irradiation. There was no weight loss due to irradiation applied 1 month after picking. (BBB)

Meat

22806 THE OCCURRENCE AND GROWTH OF STAPHYLOCOCCI ON PACKED BACON, WITH SPECIAL REFERENCE TO STAPHYLOCOCCUS AUREUS. Eddy, B. P.; Ingram, M. (Low Temperature Research Station, Cambridge, Eng.). *J. Appl. Bacteriol.*, 25: 237-47 (Aug. 1962).

S. aureus occurs and survives in bacon-curing brines and may be found on vacuum-packed bacon. Under anaerobic conditions it competes with the indigenous flora of the bacon; its growth is favored by low numbers of other organisms and by high storage temperatures. Food-poisoning strains of staphylococci failed to grow when introduced in vacuum-packed bacon. Two possible reasons were suggested for this failure of the introduced staphylococci to develop: either the bacon was unsuitable as a substrate, or the presence of other bacteria on the bacon caused an inhibition. To distinguish these possibilities, inoculations were made into packs in which the bacteria on the bacon had first been killed, and into parallel untreated controls. Unsmoked and smoked bacon samples from the same factory were sterilized by irradiation (10 Mrad), inoculated with a food-poisoning strain at a level of about 10^4 /g, and stored at 25°. After incubation for 1, 2, and 5 days, different cans were taken as samples and dilutions of homogenates of the contents were plated on agar and incubated at 44°. In 5 days there was roughly a 1000-fold increase in this count (10^4 – 10^7 /g), there being little difference between the samples of green and smoked bacon. The experiment was then repeated in a modified form. Unsmoked and smoked bacon samples from another factory were inoculated as above both with and without prior sterilization with 5 Mrad. The results were similar to those of the first experiment except that the staphylococci grew more slowly on the smoked bacon. A similar experiment was carried out in which the bacon (from a third factory) received only a pasteurizing dose (1 Mrad), so that its indigenous flora was only reduced in numbers, not eliminated. The results showed again that there is less growth of staphylococci where the normal flora are not reduced, and especially on the smoked bacon. It is evident that even severe irradiation treatments did not produce inhibitory substances in the bacon, nor was there any detectable destruction of the nitrite. *S. aureus* grows well on bacon stored anaerobically at 25° and more rapidly and attained greater numbers when the bacon had been partially or wholly sterilized by irradiation. (BBB)

26354 POSSIBILITY OF PROVING AN APPLIED IRRADIATION OF MEAT. Rumpf, G. (Bundesforschungsanstalt fuer Lebensmittelrischhaltung, Karlsruhe, Ger.). *Atompraxis*, 12: 613-17 (Dec. 1966). (In German).

Samples of beef and pork were x-irradiated with doses of 0.03 to 3 mR in air-tight packages. After extraction with water, absorption spectra of the extracts were recorded in the visible region. In beef a sharp increase in the formation of the green pigment sulfomyoglobin was noticed between 0.1 and 1 mR. Possibilities are shown for a quantitative and qualitative evaluation of this effect as a means of estimating a possibly applied dose or radiation in fresh beef. With pork no pronounced formation of sulfomyoglobin was noticed at up to 3 mR. On the basis of model experiments the greater radiation resistance of the myoglobin in pork is interpreted as a result of a higher radiation resistance of the S-containing amino acids in the protein portion. (auth)

34848 COMPARATIVE STUDY OF THE ACTION OF ^{60}Co GAMMA RAYS AND THERMAL STERILIZATION ON THE CONTENT OF THIAMINE, RIBOFLAVIN, NICOTINIC ACID, AND TOCOPHEROL IN BEEF. Syunyakova, Z. M.; Karpova, I. N. *Vop. Pitan.*, 25: No. 2, 52-5 (Mar.-Apr. 1966). (In Russian).

A comparative study was made of the vitamin composition (group B and tocopherol) in beef after its irradiation or heat sterilization. The preparation of the beef test samples for subsequent irradiation and heat sterilization was realized in identical conditions on the same day and from the same raw material. The irradiation of the prepared beef samples with dosages of 6×10^5 and 1.5×10^6 rads was effected through the medium of a 1.6×10^4 R/sec strong Co source, belonging to the All-Union Research Institute of the Canned Goods and Dehydrated Vegetables Industry. Heat sterilization specimens were prepared at an experimental canned goods factory of the Institute. The vitamin composition of the beef test samples was analyzed by using chemical methods. The resultant experimental data demonstrated that the observed decline in the level of the vitamins under study subsequent to irradiation did not exceed the losses secondary to a routine heat sterilization. (auth)

24705 GAMMA IRRADIATION OF MEATS AT VERY LOW TEMPERATURE: ATTEMPT TO IDENTIFY THE CAUSES OF SPOILAGE. Morre, Jean (Service Veterinaire, Paris). *Bull. Acad. Vet. France*, 38: 325-8 (Oct. 1965). (In French).

The reaction mechanisms of the formation of dialdehydes in γ -irradiated beef were studied. The ^{60}Co γ irradiation was conducted at the temperature of liquid nitrogen (-195°C) so that the secondary phenomena taking place could be separated from the primary ones. Three doses used were 0.5, 1, and 2 Mrad. At this temperature there was no absorption at 535 m μ when tests with thiobarbituric acid (TBA), used to complex with the reaction products, were conducted. Further experiments were conducted by irradiating the beef at the same temperature and subsequently preserving it for 5 days at -20°C . A weak TBA reaction was present in samples receiving 0.5 and 1 Mrad and a more positive one with 2 Mrad. Reactions with TBA were stronger when samples irradiated at the same temperature were preserved for 5 days at 4°C and comparable to those obtained when the material was irradiated at ambient laboratory temperature. It was concluded that the carbonyl-containing compounds detected in irradiated meat were secondary products, appearing slowly as a result of the action of the free radicals formed. Irradiation has the effect of accelerating the normal degradation processes occurring in muscle. (BBB)

32084 (AERE-R-5461) AN EVALUATION OF SEVERAL GAS-CHROMATOGRAPHIC AND COLORIMETRIC METHODS FOR THE DETECTION OF IRRADIATED HORSE-MEAT. Hills, P. R.; Smith, A. H. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). *Apr. 1967*. 28p. Dep. CFSTI. UK 3s. 6d.

A simple method is described for the differentiation of irradiated and unirradiated horsemeat by gas-liquid chromatography. Although changes which occur during the storage of irradiated samples reduce its accuracy, a range of aged laboratory samples was successfully differentiated by measurement of the total volatile content. Recommendations are made for the evaluation of this method under practical conditions. A colorimetric method for the discrimination of recently irradiated beef, which has been described in the literature, was found unsuitable for samples of aged horsemeat. (auth) (UK)

22831 (JPRS-40119) NEW TECHNOLOGICAL METHODS IN PROCESSING MEAT PRODUCTS. Sokolov, A. A. Translated from pp 432-42; 488-70 of *Fiziko-Khimicheskie i Biokhimicheskie Osnovy Tekhnologii Myasoproduktov*, Food Industry Publishing House, Moscow, 1965. 24p. (TT-67-30765). CFSTI \$3.00 cy, \$0.65 mn.

A translation of the table of contents and a chapter on radiation processing of meat is presented. The chapter includes discussions of various types of ionizing radiation, effects of irradiation on the component parts of meat products, effects on microorganisms, and irradiation of meat products. (H.L.W.)

24700 TREATMENT OF MEATS WITH IONIZING RADIATIONS. VIII. pH, WATER-BINDING CAPACITY, AND PROTEOLYSIS OF IRRADIATED RAW BEEF AND PORK DURING STORAGE, AND THE ATP-ase ACTIVITY OF IRRADIATED RABBIT MUSCLE. Lawrie, R. A.; Sharp, J. G.; Bendall, J. R.; Coleby, B. (Low Temperature Research Station, Cambridge, Eng.). *J. Sci. Food Agr.*, 12: 742-51 (Nov. 1961).

The use of electrons for the radiation processing of meats is discussed. Results are reported from studies on the pH, water-binding capacity, and proteolysis of irradiated beef and pork during storage. The effects of radiation on the ATPase activity of rabbit muscle was also studied. (BBB)

Fish and Seafood

34842 IONIZING IRRADIATION OF MARINE FISH AND MARINE FISH PRODUCTS IN GERMANY. Wittfogel, H. (Staatliches Veterinäruntersuchungsamt Stade, Cuxhaven, Ger.). Arch. Lebensmittelhyg., 16: 227-9 (Oct. 1965). (In German).

Storage tests on codfish filets packed in dried plastic containers showed that filets treated with γ radiation in doses of 75,000 R and storage under refrigeration at 4°C had ~11 days more storability than unirradiated control filets that could be stored for only 10 days. The irradiated filets could be safely stored for 21 days without noticeable evidence of any change in their appearance, odor, taste, or texture. When doses higher than 75,000 R were used the filets became unpalatable as a result of development of a burned, unpleasant odor and flavor. No tests were made as to whether the protein was damaged by irradiation, or whether the nutritional value of the fish was reduced, and if they were at all toxic, carcinogenic, or if other components were produced in the irradiated product. Bismarck herring in oil in plastic containers and irradiated with 25,000 to 200,000 R at room temperature of 18°C lasted only 2 to 4 days longer than unirradiated controls. The herring that were irradiated with more than 75,000 R developed such strong odors and taste that they were unmarketable. The taste of the herring irradiated with 75,000 R had an improved flavor, but even with the 2 to 4 day storability increase the costs were too high to make the procedure economically feasible. When sea salmon were irradiated with 50,000 R, the storability at room temperature was not increased and above 50,000 R irradiation produced objectionable changes in odor, flavor, and coloration. (BBB)

24698 A COMPARISON OF TOXIN PRODUCTION BY CLOSTRIDIUM BOTULINUM TYPE E IN IRRADIATED AND UNIRRADIATED VACUUM-PACKED FISH. Cann, D. C. (Torry Research Station, Aberdeen, Scot.); Wilson, Barbara B.; Shewan, J. M.; Roberts, T. A.; Rhodes, D. N. J. Appl. Bacteriol., 29: 540-8 (Dec. 1966).

Possible use of pasteurizing doses of radiation to extend the storage life of fish or fish products was investigated, and in particular the time for toxin production at 10°C from spores in fish after irradiation at a pasteurizing dose was determined. The fish were inoculated first, so that the spores themselves were irradiated, and some inactivated, and the growth subsequent to germination took place on irradiated fish. The time for toxin production was compared with that for comparable numbers of unirradiated spores in unirradiated fish. Toxin production by inocula of 10^5 , 10^4 , 10^3 , and 10^2 spores of *Clostridium botulinum* type E in vacuum packed herring, cod, and haddock were compared with that of equivalent numbers of spores surviving γ irradiation at 300,000 rads. There was little difference between the rates of toxin production in unirradiated and irradiated fish. More toxin was produced in irradiated herring than in unirradiated, but in haddock the reverse was obtained. In cod about equal amounts of toxin were found without trypsinization; after trypsinization toxin levels were generally higher in irradiated samples. (BBB)

41526 EFFECT OF PASTEURIZING DOSES OF GAMMA RADIATION ON STORAGE LIFE OF COOKED LOBSTER MEAT. Power, H. E.; Fraser, D. I.; Dyer, W. J.; Neal, W. J.; Castell, C. H. (Fisheries Research Board of Canada, Halifax). J. Fish. Res. Board Can., 24: 221-30 (Feb. 1967).

The effect of pasteurization doses (75,000 to 250,000 rad) of ^{60}Co γ radiation on the organoleptic characteristics and storage life of cooked lobster meat stored at 0°C was studied. The initial bacterial count of the iced control samples was 6900 colonies per g lobster meat. Irradiation at 75,000 rad reduced the count to 120, at 150,000 and 250,000 rad to less than 100. After 7 days storage in ice at 0°C, the bacterial count per g of the iced control samples had reached 129,000 whereas the count for all irradiated samples was less than 100. The trimethylamine (TMA) values of the iced control meat increased rapidly after 20 days storage to >30 mg N/100 g, while values for the irradiated samples remained below 10 mg N/100 g for 30 days but then increased rapidly. Irradiation with 75,000 to 250,000 rad thus inhibited the growth of TMA-producing bacteria for 10 days longer than on iced controls. Taste panel tests revealed that meats irradiated at 75,000 rad did not differ initially from the iced control meats; scores decreased gradually, as a result of developing acid-sweetish, seaweedy, and stale flavors. Irradiation at 150,000 and 250,000 rad reduced the initial taste scores due primarily to a loss of the sweet, fresh flavor and to the presence of slight irradiation odors and flavors, especially after 250,000 rad. The meats irradiated at 150,000 were acceptable up to 35 days. It was concluded that irradiation at 75,000 rad can be used to extend the storage life, in ice, to between 28 and 35 days for both tail and claw meats from 14 to 21 days for unirradiated iced samples. Higher irradiation levels cause an immediate loss of quality due to toughening and loss of flavor. (BBB)

28679 DEVELOPMENT OF YEAST ON IRRADIATED PACIFIC CRAB MEAT. Eklund, M. W.; Spinelli, J.; Miyauchi, D.; Das-sow, J. (Bureau of Commercial Fisheries, Seattle). J. Food Sci., 31: 424-31 (May-June 1966).

This report describes the factors affecting growth of yeasts in irradiated crab meat; the genera of yeasts present on the unirradiated product and those surviving the irradiation treatment and growing on the refrigerated product; and the biochemical activities of the different genera that might be potentially deleterious to the product. King crab and Dungeness crab were irradiated with doses of 0.2 or 0.4 Mrad. Yeasts increased rapidly on air-packed irradiated samples of crab meat stored at 0.5 and 5.6°C. The growth of the yeasts on irradiated crab meat was inhibited by vacuum-packing the sample. No appreciable increase in yeast counts occurred on the unirradiated controls. A total of 569 yeast cultures were isolated from unirradiated and irradiated crab meat. The genera represented included *Rhodotorula*, *Cryptococcus*, *Torulopsis*, *Candida*, *Trichosporon*, and a yeastlike organism resembling *Aureobasidium pullulans*. Members of *Cryptococcus*, *C. acidica*, and *A. pullulans* were gelatinolytic and lipolytic. *Trichosporon* isolates were very active in attacking gelatin, casein, and triglycerides. The yeast populations were considerably higher on irradiated samples, probably because of elimination of bacteria which compete with yeasts for available nutrients. (BBB)

34841 (JPRS-41012) CHANGES IN THE PROPERTIES OF FRESH FISH UNDER THE EFFECT OF GAMMA RAYS. Kardashev, A. V.; Korzhova, Yu. A. Translated from Tr. Vses. Nauch.-Issled. Inst. Morsk. Ryb. Khoz. Okeanogr., 45: 15-25 (1962). 21p. (TT-07-31054). CFSIT.

Samples of fresh fish placed in glass jars filled with carbon dioxide and vacuum-sealed at atmospheric pressure were irradiated at 0.2 to 2.0 million R. The irradiated samples were stored at 15 to 18°C and at 0 to 5°C. The effects of irradiation on enzyme activity, numbers of microorganisms, organoleptic properties, and the physico-chemical properties were assessed. It was concluded that: at doses of 1.5 to 2.0 million R, the fresh fish was rendered practically sterile; enzymes were not inactivated and that autolytic processes took place during the time of storage; the time of storage of irradiated fish was 2 wks to 3 mo; the organoleptic properties were somewhat changed since a change in color, shrinkage of the flesh, and a strange smell and after-taste occurred; and that irradiation provoked changes in the globulin content, flesh consistency, lipid content, and pH. (B.H.S.)

24697 EFFECT OF PACKAGING ON THE MAJOR MICROBIAL FLORA OF IRRADIATED HADDOCK. Sinskey, T. J. (Massachusetts Inst. of Tech., Cambridge); Pablo, I. S.; Silverman, G. J.; Ronsivalli, L. Nature, 213: 425-6 (Jan. 28, 1967).

It is stated that a factor which has been neglected in studies on the irradiation preservation of sea foods is the effect of packaging and accessibility of air on microflora growth patterns. In the investigation described, haddock filets were packaged in cans (a) without hermetic sealing but covered with aluminium foil to allow free exchange of air, (b) sealed with a limited air headspace, (c) vacuum packed. The samples were exposed to 150 Krads and then stored at 3°C for 3 weeks. Results indicated that the microbial spectrum is altered by the presence of air during refrigerated storage. A detailed analysis of microbial species is given. (INIS-UK)

26686 BACTERIOSTATIC EFFECT OF ^{60}Co γ -RAY IRRADIATION ON OYSTER. Sasaki, Satoshi (Lab. of Public Health, Hiroshima Prefecture, Japan); Kajiura, Nobuyuki. Hiroshima-ken Eisei Kenkyusho, No. 13, 22-7 (Mar. 1963). (In Japanese).

The bacteriostatic effect of ^{60}Co γ irradiation on oysters was experimentally studied. Suspensions of 8 kinds of bacteria were isolated from shucked oysters, including 3 Gram-negative bacilli, 2 Gram-positive bacilli, 1 *Enterococcus*, 1 *Streptococcus viridans* and 1 *Staphylococcus*, in a physiological sodium chloride solution and were irradiated by ^{60}Co γ -rays. A dose of 7×10^4 R (60 minute irradiation) reduced the number of living germs to 0.003 to 0.0001% of that before irradiation. When the same 8 species were irradiated in an oyster emulsion, the reduction in the numbers of living germs was slight: the numbers were reduced to 9.03,

0.03 and 0.01% of those before irradiation in the 60, 120, 300, and 600 minute irradiations, respectively. To produce the same effects as in the case of suspensions in physiological sodium chloride solution, five times as large a dose was required. Oysters were irradiated with a dose of 3.5×10^5 R (300 minute irradiation), and the bacteriostatic effect was examined. The number of living germs was reduced to 0.02%. (NSA of Japan)

Poultry and Eggs

26334 THE EFFECT OF HEATING AND γ -IRRADIATION ON THE ENZYME ACTION SUSCEPTIBILITY OF EGG WHITE PROTEINS. Kurokawa, Kazuo. *Eiyo To Shokuryo*, 18: 187-9(1965). (In Japanese).

Heat-coagulated egg white proteins are digested at 37°C for 30 minutes by pepsin and trypsin. Susceptibility of egg white proteins to pepsin was not affected by heating of proteins, while that to trypsin was increased with increasing temperature of heat treatment. When egg white proteins were heated and then irradiated with ^{60}Co gamma rays, no dose effect was found for their susceptibility to pepsin and trypsin. In the case of post treatment by heating, there was no temperature effect on the susceptibility to the pepsin action. Considerable combined effects of irradiation and post-heating on the susceptibility to trypsin were observed. (auth)

28705 IRRADIATION OF POULTRY AND EGG PRODUCTS AS SUPPLEMENT TO FREEZING. Boersma, H. Y. (Instituut voor de Pluimveeteelt "Het Spelderholt," Beekbergen, Netherlands). *Conserva (The Hague)*, 15: 18-19(July 1966). (In Dutch).

Use of ionizing radiation for sterilization or pasteurization of poultry products, along with other preservation methods, is examined. For poultry the results obtained with radiation pasteurization have been encouraging, in comparison with other meat products. The use of irradiation combined with cold storage seems promising. Treatment with sterilizing doses (~4.5 Mrad) fails to inactivate enzymes, which lead to deterioration of flesh, when storage is not at low temperatures. Possibilities of using heat treatment with irradiation are considered. Radiopasteurization is accomplished with doses of 0.4 to 0.5 Mrad, which markedly lower the Salmonella count. For radiation processing of eggs, prior freezing is essential. Similar pasteurization doses (~0.5 Mrad) are successful in reducing the Salmonella count of frozen egg products. Comparisons are made with heat treatment. There is evidence that radiopasteurization may be of real value in preservation of frozen egg. (BBB)

Miscellaneous Foods

32813 IRRADIATED BLOOD MEAL AND BONE MEAL FOR RATS. Eggum, Bjoern O.; Swift, Robert L. (Landoekonomisk Forsogslaboratoriums, Copenhagen). *Landokonom. Forsogslab. Arbog*, (Copenhagen), 45-7(1965). (In Danish).

Heat-sterilized and radiosterilized blood and bone meal, used for fattening pigs, were comparatively tested for nutritive value in rats. The heat-treated materials were maintained at 125°C for 15 min and the radiation-treated material were sterilized with 500,000- to 2,000,000-rad doses of γ radiation. When tested as the only protein supplement of the diet or when combined with soybean meal, both irradiated blood meal and bone meal proved to be more efficient for growth in rats than the heat-treated counterparts. It was evident that the protein-anabolic efficiency of the irradiated products was higher than that of the heat-sterilized materials. This was confirmed by the higher contents of essential amino acids, especially lysine, in the radiosterilized feed. (BBB)

34851 IRRADIATED BLOOD MEAL AND BONE MEAL FOR SLAUGHTER SWINE. Hansen, Villy (Landoekonomisk Forsogslaboratorium, Copenhagen). *Landokonom. Forsogslab. Arbog*, (Copenhagen): 37-45(1965). (In Danish).

A comparison was made of the physical, chemical, and biological properties of heat- and radiation-sterilized blood and bone meal used as feed for pigs. The heat-treated material was kept at 125°C for 15 min. Radiosterilization was carried out with doses of 5×10^5 to 20×10^5 rad. Both Danish and imported products were examined for contents of protein, nitrogen, ash, and other constituents after heat and radiation treatment. Nutritive values were also determined; on the basis of lysine content (4.11 and 4.44 in heated and irradiated blood meal and 7.52 and 8.57 in bone meal, respectively), it was evident that radiosterilization allowed for greater preservation of essential amino acids. Complete amino acid analyses of the products also revealed higher contents of most nonessential and essential amino acids in both blood and bone meal treated with radiation as compared to that sterilized with heat. Mycological and bacteriological studies revealed the adequate reduction of microorganisms in the irradiated products; mold and bacteria counts fell from 400 to <100 and 80,000 to <100 per g in irradiated blood meal and from 700 to <100 and 65,000 to 3000 per g, respectively, in irradiated bone meal. (BBB)

32817 EFFECT OF GAMMA IRRADIATION ON MALTING BARLEY. Fujii, Toshikatsu; Lewis, Michaelis J. *Rep. Res. Lab. Kirin Brewery Co., Ltd.*, No. 8, 59-66(Dec. 1965).

Results of the experiments reported confirm the dependence of the aleurone layer on stimulation by the embryo, prior to production of amylase enzymes during germination of barley. The results show, in addition, that the hormone capable of stimulating the aleurone layer to synthesize enzymes appears in the embryo just prior to stimulation of the aleurone layer. Gamma irradiation of barley causes greater damage to the embryo than to the endosperm (aleurone layer) of the barleycorn, and it is primarily this inactivation of the embryo that causes decreased enzymatic content of malts made from irradiated barley. Irradiation significantly reduces rootlet growth as part of the overall reduction of the metabolic activity of the embryo. (NSA of Japan)

32812 (SGAE-BL-19/1967) KONSERVIERUNG VON BROT MITTELS GAMMASTRAHLUNG. (Preservation of Bread by Gamma Irradiation). Stehlik, G.; Kaendl, K. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf, Institut fuer Biologie und Landwirtschaft). 1967. 27p. (In German). Dep.

The extension of the storage-life of slices of bread using γ irradiation alone and also combined with heat or chemical pretreatment was investigated. Results showed that by using combined methods to extend storage-life to 8 to 10 weeks it was possible to apply doses which are already authorized in the USA for wheat and wheaten flour. The organoleptic qualities of this bread were also investigated. No difference could be noted immediately after irradiation, even at a dose of 5×10^5 rad, in comparison with the non-irradiated control sample. After storing the irradiated sample for 2 months at room temperature there was naturally a deterioration in quality in comparison to fresh bread; this, however, was due to the long storage period and not to the irradiation itself. The quality of the irradiated bread, in comparison to the canned sample, was slightly better. (auth)

Medical Supplies

22833 EFFECTS OF IONIZING RADIATION ON PHARMACEUTICALS. Wills, Pamela A. (Australian Atomic Energy Research Establishment, Lucas Heights). *Austral. J. Pharm.*, 44: S50-7(May 30, 1963).

Use of radiation to sterilize drug preparations is considered and the literature is reviewed relating to the effects of radiation on the following: vitamins, steroids, hormones, alkaloids, antigens, antibiotics, carbohydrates, and enzymes. Few data have appeared in the literature dealing specifically with the actual degradation products of the pharmaceuticals which do not withstand radiation treatment, so this survey is mainly confined to indicating which products may or may not be successfully radiosterilized. The fact that little work has been carried out on the identification of the degradation products formed from radiation-sensitive materials prevents understanding of the reactions concerned, so that additives can be introduced to combat these deleterious effects. A discussion is provided on the 2 ways in which radiation by direct action can be obtained: when the molecule undergoing change is itself ionized or excited by the passage of an electron and by indirect action, when it receives energy by transfer from some other molecule. Direct action can occur when substances are irradiated in the pure dry state; in aqueous solutions or living tissue, action may be direct or indirect. When dilute aqueous solutions are irradiated, indirect action occurs. The indirect effects of radiation may be modified, for example, by the use of very pure water, or by freezing, which prevents the diffusion of the reactive components. Both direct and indirect action may be altered by the presence of oxygen or the addition of certain other solutes which may provide protection by competing for the free radicals and activated molecules. Molecules which possess resonance and can absorb a considerable amount of energy before excitation occurs may exert a protective effect when combined with more sensitive compounds. This review reveals that ionizing radiation is not useful for sterilization of all pharmaceutical products. Rather, each individual product must be examined insofar as sterility, dose requirements, reactions of the product in its various physical forms, effects of pH, effects of the packaging material on these reactions, possible toxic manifestations, and clinical testing are concerned. (BBB)

34843 APPLICATION OF IONIZING RADIATION TO THE STERILIZATION OF DRUGS, BIOLOGICAL PRODUCTS, AND THERAPEUTICAL INSTRUMENTS. Antony, Ferenc. *Orv. Hetil.*, 107: 1216-18(June 26, 1966). (In Hungarian).

The sterilization of drugs, biological products, and medical instruments with ionizing radiation is reviewed. (JPRS)

28710 RADIATION STERILIZATION IN MEDICINE: PRESENT APPLICATIONS AND FUTURE PROSPECTS. Antoni, F. (International Atomic Energy Agency, Vienna); Kozinets, G.; Koeteles, G. *At. Energy Rev.*, 4: No. 3, 39-61(1966). (In Russian). English: ORNL-tr-1502

An attempt was made to summarize all the available data on the utilization of ionizing radiation for the sterilization of medical supplies. It is shown that radiosterilization of medical instruments and bandages is of definite practical use. Future uses of ionizing radiation for sterilization of biological tissues, synthetic materials, and various medications which cannot be subjected to chemical or thermal sterilization are discussed. (178 references.) (tr-auth)

26706 USE OF GAMMA-RAY-STERILIZED CELLOPHANE MEMBRANES IN KIDNEY. Berlyne, G. M. (Manchester Royal Infirmary, Eng.); Crooks, L. G. pp 285-8 of *Proc. European Dialysis and Transplant Assoc.* Vol. 2, 1965. Kerr, David N. S. (ed.). Amsterdam, Excerpta Medica Foundation, 1966.

The use of γ -ray-sterilized dialysis membranes in an artificial kidney was demonstrated. The dialysis membrane consists of cellophane folded into two layers, placed in a polythene envelope, and irradiated with γ rays (2.5 Mrad). Cost is 15 shillings per cannister, sufficient for 10 kill kidney dialyses. The technique whereby the radiosterilized membranes are inserted into the apparatus is described in detail and illustrated. It is concluded that, for this type of artificial kidney, γ -ray-sterilized membranes are the method of choice. Sterilization is always complete and is cheap. One technician alone can prepare an artificial kidney ready for instant use within 15 min. Dialysance is not affected by γ irradiation. (BBB)

21992 EFFECT OF IONIZING RADIATION ON SOME THERMOLABILE COMPOUNDS. I. BEHAVIOUR OF PHENYLETHYL-BARBITURIC ACID AND ITS SODIUM SALT UNDER EFFECT OF γ ^{60}Co RADIATION. Bednarczyk, Wladyslaw; Bukowska, Hanna (Inst. of Pharmaceuticals, Warsaw). *Przem. Chem.*, 45: 566-9 (Oct. 1966). (In Polish).

In studies on the usefulness of ionizing radiation in sterilization of thermolabile pharmaceuticals, phenylethylbarbituric acid and its sodium salt, in the form of a solid and an aqueous solution, were submitted to 2×10^6 RAD of gamma ^{60}Co radiation. The stability of the compounds examined was established by observation of the exterior of samples, their solubility, melting point determination, and studies of their infrared and ultraviolet absorption spectra. (auth)

Hides

34852 EMPLOYMENT OF GAMMA RADIATIONS FOR STERILIZING THE CARCASSES OF FOOT-AND-MOUTH DISEASE VIRUS-INFECTED ANIMALS. Baldelli, B.; Begliomin, A.; Frescura, T.; Massa, D. (Istituto Zooprofilattico Sperimentale dell'Umbria e delle Marche, Perugia, Italy). *Atti Soc. Ital. Sci. Vet.*, 19: 538-42(1965). (In Italian).

The possibility of using ionizing radiation for elimination of the hoof-and-mouth disease virus from domestic animals was investigated. Three pigs were infected intradermally with the virus (type A, C, or O); 40 to 45 hr later (when they manifested the usual symptoms of the disease) they were slaughtered and the carcasses were frozen at -30°C . Samples of blood, lymph nodes, and vertebral bone marrow were irradiated with 0.25- to 2-Mrad doses of γ radiation from ^{60}Co . Virus titers in the tissues were then determined in calf kidney cell cultures. Type A and O virus was appreciably decreased in blood after doses of 0.25 Mrad and eliminated after 0.75-Mrad treatment. Type C virus in blood was more resistant and required a dose of 1.75-Mrad for elimination. In general, lower doses were necessary for eradication of the virus from lymph nodes and bone marrow (1.25 Mrad for types C and O, and 0.25 for type A). The results showed that with adequate doses of γ radiation infected carcasses could be made edible. (BBB)

PROCESS RADIATION DEVELOPMENT

40932 IMPROVEMENTS IN AND RELATING TO THE CARRYING OUT OF RADIATION-INITIATED CHEMICAL REACTIONS. (to Farbwerke Hoechst Aktiengesellschaft). British Patent 1,081,394. Aug. 31, 1967. Priority date Sept. 6, 1963, Germany.

A process and an apparatus are described for carrying out radio-induced chemical reactions using γ radiation from a power reactor. The vessel containing the chemical reactants is placed outside the nuclear reactor vessel between the wall of the reactor vessel and the biological shield. The chemical reaction vessel at least partially replaces the thermal shield, which consists of a container filled with an aqueous solution of B or Cd salts or a mixture of these. (B.L.M.)

23914 ECONOMIC CONSIDERATION ON INDUSTRIAL APPLICATION OF RADIATION CHEMISTRY. Danno, Akibumi (Japan Atomic Energy Research Inst., Tokyo). *Kagaku Kogyo*, 17: No. 9, 1-7(Sept. 1966). (In Japanese).

In the industrialization of radiation chemistry, the four following areas are important: sufficient basic studies; technological possibilities; economics; and marketability of the products. Viewed from this standpoint, the only radiation-chemical process developed to the commercial stage is the production of ethyl bromide by the hydrobromination of ethylene using gamma irradiation. The cost for the production of ethyl bromide by this process is estimated. When the plant capacity is taken as 454 tons/year, the investment for the plant construction is 4.38×10^7 yen, and the total cost is 309 to 511 yen/kg ethyl bromide, depending on the method of shipment. The cost for irradiation is estimated to be only 9 yen/kg ethyl bromide, which may be decreased with an increase in plant capacity. (NEA of Japan)

40922 INDUSTRIAL PERSPECTIVES OF RADIATION CHEMISTRY. Dobo, Janos, Magy. *Kem. Lapja*, 22: 293-300(June 1967). (In Hungarian).

Chemical reactors, when constructed, will furnish radiation energy at very low cost and in high quantities. For the near future, however, sources independent of reactor operation (cobalt sources and accelerators) are of interest for Hungary. Since the radiation from such sources is comparatively expensive, only processes of high effectivity can be envisaged for industrial application. As to the choice between isotopes and accelerators, the type of process, economics, and running experiences have to be considered. (auth)

Polymerization

40888 DEGRADATION AND CROSS-LINKING OF POLY-DIMETHYLSILOXANE) IN SOLUTION UNDER THE INFLUENCE OF ^{60}Co γ RAYS. Schnabel, Wolfram (Hahn-Meitner-Institut fuer Kernforschung, Berlin). *Makromol. Chem.*, 103: 103-8 (1967). (In German).

Radiochemical yields for main-chain scission and for cross-linking were determined for pure poly(dimethyl siloxane) as well as for poly(dimethyl siloxane) irradiated in toluene solutions at various concentrations. For pure poly(dimethyl siloxane) the ratio of the specific densities of degradation and crosslinking p_d/q_d amounted to 0.015. In toluene solution, p_d/q_d steadily increased with decreasing concentration and approached infinity at a base mole fraction of the polymer of $x_p = 0.03$. At the critical concentration ($x_{p\text{crit}} = 0.15$), p_d/q_d was equal to 2. The 100 eV-yield of crosslinking decreased with decreasing polymer concentration and became zero in very dilute solutions. The 100 eV-yield for main-chain scission slightly increased with decreasing polymer concentration over a broad range of x_p ; a more significant increase occurred at low concentrations. The results agreed with the previously developed theory of simultaneous degradation and crosslinking of polymers in solution under the influence of ionizing radiation. (BBB)

40890 EFFECT OF SOME PHOTSENSITIZERS ON THE RADIATION-CHEMICAL CROSSLINKING OF POLYETHYLENE. Kachan, O. O.; Chernyavs'kii, G. V.; Shrubovich, V. O. (Inst. of Chemistry of High-Molecular Compounds, Kiev). *Dopov. Akad. Nauk Ukr. RSR*, Ser. B, No. 7, 626-8(July 1967). (In Ukrainian).

Effects of the additives of chloroform, carbon tetrachloride, tetrachloroethylene, benzophenone, and phosphorus trichloride on the radiation-chemical crosslinking of polyethylene were studied. It was established that benzophenone, tetrachloroethylene, and phosphorus trichloride influence rather little the crosslinking of polyethylene under the action of γ rays from ^{60}Co . Carbon tetrachloride and chloroform were inhibitors of the process. (auth)

40903 RADIOINDUCED POLYMERIZATION OF THE THREE-DIMENSIONAL CYCLIC DICYCLOHEXYLPHOSPHINOBORANES. Solomatina, A. I.; Chikishev, Yu. G.; Tsetlin, B. L.; Zamyatina, V. A.; Korshak, V. V. (Inst. of Elementary Organic Compounds, Moscow). *Izv. Akad. Nauk SSSR, Neorg. Mater.*, 3: 381-3 (Feb. 1967). (In Russian).

Previously it was shown that the effects of ionizing radiation on dimethylphosphinoborane induced formation of polymer products of linear and polycyclic structures. An attempt was made at inducing radiation polymerization in three-dimensional dicyclohexylphosphinoborane (DCHPB). The three-dimensional dicyclohexylphosphine prepared, following crystallization from benzene, had a melting point of 255 to 256°C, molecular weight 710, and was easily dissolved in ether, benzene, and heptane but did not dissolve in methanol. Transformation of the monomer to a polymer for a specimen of DCHPB irradiated with 0.5×10^{10} RAD was 32.2%; for the specimen irradiated with 0.2×10^8 RAD it was 20.7%; and for the specimen irradiated with 0.2×10^6 RAD it was 21%. The data obtained indicated that radioinduced polymerization of the three-dimensional DCHPB is accompanied by broken rings and produced linear polymers and splitting cyclohexane molecules after further irradiation. The resulting tetra-coordinated structure transformed into a less stable tricovalent one and the polymer obtained was easily oxidized by precipitation in air. (R.V.J.)

40894 CATIONIC POLYMERIZATIONS INDUCED BY RADIATIONS. Cordischi, D.; Mele, A. (CNEN, Rome). *Chim. Ind. (Milan)*, 49: 151-62 (1967). (In Italian).

This review (47 references) discusses some recent theories on distribution and stability of primary ionic species produced in the liquid phase by ionizing irradiation. On the basis of proposed models, a kinetic scheme is examined for radioinduced ionic polymerization. Examples are given of monomers that polymerize through ionic intermediates. How the presence of ionic species acceptors effects polymerization is discussed. Particular attention is given to polymerization of isobutylene, styrene, and α -methylstyrene. Effects of solvent, temperature, and other factors in cationic polymerization induced by ionizing radiation are also considered. (BBB)

45159 DEGRADATION AND BRANCHING OF POLY(VINYL ACETATE) IN SOLUTION BY THE ACTION OF ^{60}Co γ RADIATION. Schnabel, Wolfram; Schamberg, Eckehard (Hahn-Meitner-Institut fuer Kernforschung, Berlin-Wannsee, Ger.). *Makromol. Chem.*, 104: 9-17 (1967). (In German).

Linear poly(vinyl acetate) having an approximately random molecular weight distribution was γ -irradiated in acetone solution at various concentrations. It was shown by light scattering and viscosity measurements that at concentrations below the critical concentration for gel formation the polymer is crosslinked to a certain extent in addition to the predominant degradation of the main chain. In accordance with the previously developed theory of simultaneous crosslinking and degradation, the ratio of the sp degradation and crosslinking densities (P_0Q_0) increases with decreasing polymer concentration and surpasses the value 2 at the critical concentration. (BBB)

42987 RADIATION-INDUCED TERPOLYMERIZATION OF SULFUR DIOXIDE, ACRYLONITRILE, AND OCTENE-1. Ito, Masayuki; Kuri, Zen-ichiro (Nagoya Univ., Japan). *Kogyo Kagaku Zasshi*, 70: 1011-12 (June 1967). (In Japanese).

Terpolymerization of SO_2 , acrylonitrile (AN) and octene (Oct) by ^{60}Co γ rays was investigated. The composition of polysulfones obtained was found to be of the form of $(\text{AN})_x(\text{SO}_2-\text{Oct})_y$, the ratio of Oct/ SO_2 in the polysulfone was about 1/1, independent of monomer concentrations. Assuming the terpolymerization of this system to be the copolymerization of AN and SO_2 -Oct complex C, the following result was obtained: $C/\text{AN} = (\text{C}=\text{AN}) \times [20(\text{C}) + \text{AN}]/[\text{C} + 0.2(\text{AN})]$, where (C) is the concentration of the complex in starting materials and C is the mole fraction of SO_2 -Oct in polysulfone. The polysulfones were soluble in DMF, and became soluble even in acetone or benzene, as the contents of AN in the copolymers decreased. (NSA of Japan)

42979 RADIATION-INDUCED POLYMERIZATION OF ISOBUTENE IN THE GAS PHASE. Okamoto, Hidemasa; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). *J. Phys. Chem.*, 71: 3222-7 (Sept. 1967).

The γ -induced polymerization of isobutene was investigated at 25°C in the gas phase to elucidate its reaction mechanism. The initial rate of polymerization was directly proportional to dose rate. The polymerization was markedly retarded by the presence of NH_3 , indicating a cationic mechanism. Nitric oxide and nitrous oxide also showed considerable retarding effects on the polymerization. The rate of polymerization was enhanced by adding rare gases, Ar, Kr, and Xe. These results indicated that energy transfer from rare gases to isobutene occurs in mixtures of these gases. (auth)

45173 POLYMERIZATIONS IN THE GLASSY STATE. Chap-iro, A. (CNRS, Bellevue, France). *Chimia (Aarau)*, 21: 454-9 (Sept. 15, 1967). (In French).

Numerous vinyl monomers polymerize rapidly when irradiated at low temperature (-78 to -196°C) in vitreous mixtures with oils, polymers, or certain solvents. The kinetic features of all these reactions are similar: very high conversions can be reached; polymerization rates and molecular weights exhibit a maximum for diluted monomer solutions. The polymerization proceeds by a free-radical mechanism in hydrocarbon media; it may be anionic if the solvent used is an amide or an amine, or cationic in a halogenated compound. The structure of the binary glasses was investigated and it was found that phase separation occurs at low temperature, the monomer being dispersed in little droplets embedded in the vitreous medium. The polymerization occurred in these droplets, which may remain in a supercooled state, at temperatures as much as 80°C below the normal melting point of the monomer. When the mixtures were irradiated at temperatures below the glass transition point of the monomer, a polymerization was observed that may still proceed very rapidly. This reaction occurred at a temperature very close to the transition point in a highly viscous medium in which chain termination was strongly reduced. (auth)

45156 ON THE CROSSLINKING OF PARTIALLY PHENYL-SUBSTITUTED POLYDIMETHYLSILOXANE BY ^{60}Co γ RADIATION. Schnabel, Wolfram (Hahn-Meitner-Institut fuer Kernforschung, Berlin-Wannsee, Ger.). *Makromol. Chem.*, 104: 1-8 (1967). (In German).

Copolymers of dimethyl siloxane and phenyl methyl siloxane (type I) as well as copolymers of dimethyl siloxane and diphenyl siloxane (type II), were γ irradiated with ^{60}Co . In the case of type I polymer containing 36 mole % phenyl groups, it was found that scissions in the main chain are negligible compared with intermolecular crosslinking. The 100 eV for crosslinks $G(X)$ decreased with increasing phenyl-group content. At equal contents of phenyl groups, polysiloxanes of type II were less radiation stable than those of type I. For both types of copolymers the 100-eV yield $G(X)$ depended linearly on the electron fraction of the dimethyl siloxane units. It was concluded that phenyl-substituted siloxane units do not protect neighboring dimethyl siloxane units as has been assumed in some previous studies. (BBB)

42981 RADIATION-INDUCED POLYMERIZATION BY FREE IONS. PART 3. RATE CONSTANTS FOR CATIONIC POLYMERIZATION. Williams, Ffrancois; Hayashi, Kanae; Ueno, Katsuji; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). *Trans. Faraday Soc.*, 63: 1501-11 (June 1967).

The general kinetics of radioinduced ionic polymerization are discussed and the effects resulting from impurity termination are analyzed quantitatively. A method is described for calculation of the propagation rate constants k_p by combining measurements of polymerization rates with conductivity determinations of the ionic lifetime in the stationary state. The rate constant for cationic propagation by free ions is ca $4 \times 10^6 \text{ M}^{-1} \text{ sec}^{-1}$ for both styrene and α -methylstyrene in the bulk monomer. This large value suggests that the lower results obtained previously for styrene by the use of chemical cationic catalysts refer mainly to ion pairs of varying reactivity. (auth) (UK)

24010 RADIATION POLYMERIZATION OF THE NON-ISOMORPHOUS SYSTEM OF ACRYLAMIDE-CARBAMIDE. Kiss, L.; Polgar, S.; Grell, M.; Barkaszi, B. (Research Inst. for Plastics, Budapest). pp 621-32 of *Proceedings of the Second Tihany Symposium on Radiation Chemistry*. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The phase diagram of the system acrylamide-carbamide showed two eutectic points at 64 and 77.5 mole % acrylamide. A molecular compound is formed at 73 mole % acrylamide. The γ -induced polymerization of the nonisomorphous system proceeds at low temperatures (-16 and -78°C) at which pure acrylamide does not polymerize. The polymerization reaches a maximum at the eutectic point and a minimum where the molecular compound is formed. Microphotographs of the two-component system and of both pure components are shown. The effects of crystal structure on the polymerization rate and on the limiting conversion values were studied. The initial polymerization rates of microcrystalline samples obtained by rapid cooling are considerably higher than those obtained for macrocrystalline samples obtained by slow cooling. After initial polymerization, the situation is reversed, and the polymerization rates of the macrocrystalline samples are higher. (B.L.M.)

25881 RADIATION POLYMERIZATION OF N-HYDROXY-MALEIMIDE. Ivanov, V. S.; Smirnova, V. K.; Yung, Tsao (Leningrad State Univ.). *Vysokomol. Soedin.*, 9: 899-903 (Apr. 1967). (In Russian).

N-hydroxymaleimide was polymerized in dimethylformamide (DMFA) solution at 20°C by γ -irradiation of ^{60}Co . The effects of dose, dose rate, monomer concentration, Santovar A, β -naphthylamine, and CCl_4 additives on polymerization were studied. In gaseous products formed at polymerization CO is found. The polymer is characterized by its solubility, intrinsic viscosity, softening, and decomposition temperature using x and ir techniques. (auth)

23932 POLYMERIZATION OF ETHYLENE BY γ -RAYS. I. PURE ETHYLENE. Dauphin, J.; Grosmanin, J.; Petit, J. C. (Compagnie Francaise de Raffinage, Gonfreville l'Orcher, France). *Int. J. Appl. Radiat. Isotop.*, 18: 285-96 (May 1967). (In French).

The gamma-induced polymerization of pure ethylene was studied systematically. Variations of the polymerization rate and of the resulting molecular weights were investigated in the following ranges: pressures from 70 to 500 atm, temperatures from -25 to 135°C, and dose rates from 8 to 16,000 rad/min. The polymer formed at low temperature had the appearance of a very fine powder and its specific surface area was large. This decreased as the temperature increased and could no longer be measured when the temperature reached 90°C; the polymer particles then stuck together. The variations of the specific surface area had a considerable influence on the rate of polymerization and on the molecular weights. These facts led to the assumption of the co-existence of two mechanisms of polymerization: one is classical and takes place in the homogeneous phase; the other involves growing from the polymer surface. This assumption remains valid as long as the specific surface area of the polymer keeps a measurable value. Such a hypothesis should explain qualitatively the main features of the reaction. (auth)

23933 POLYMERIZATION OF ETHYLENE BY γ -RAYS. II. INFLUENCE OF IMPURITIES AND ADDITIVES. Dauphin, J.; Grosmanin, J.; Petit, J. C. (Compagnie Francaise de Raffinage, Gonfreville l'Orcher, France). *Int. J. Appl. Radiat. Isotop.*, 18: 297-305 (May 1967). (In French).

The gamma-induced polymerization of ethylene was studied in the presence of various impurities and additives. Oxygen, water, carbon dioxide, and propylene induced inhibition periods, followed by slower polymerization than for pure ethylene. Oxygen was the most effective inhibitor. A reduction of the rate occurred in the presence of acetylene; it probably copolymerizes with ethylene. Hydrogen, methanol, and saturated hydrocarbons had only a slight effect on the rate of polymerization and reduced the molecular weights. The influence of ammonia was quite different. It increased the polymerization rate but had a minor effect on the molecular weights. Several hypotheses were suggested for explaining this. An increase in radical yield could occur by charge transfer, excitation transfer, or proton transfer. As the polymerization takes place mainly on the polymer surface area, ammonia could cause a physical effect, altering the interactions between monomer and polymer. Ammonia could also react with traces of impurities, such as with carbon dioxide. A choice could not be made among these various mechanisms, but they could work simultaneously. (auth)

23977 EFFECT OF COMPLEXING AGENTS ON THE POLYMERIZATION OF ALLYLIC MONOMERS. Kulikova, V. F.; Savinova, I. V.; Zubov, V. P.; Kabanov, V. A.; Polak, C. S.; Kargin, V. A. (Moscow State Univ. Petrochemical Inst., Moscow). pp 493-9 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The γ -induced polymerization of allyl acetate and allyl alcohol was greatly enhanced by the addition of ZnCl_2 . In both cases, the rate of polymerization depended approximately on the first power of the dose rate and very little on the temperature. The physicochemical properties of the polymers changed considerably with ZnCl_2 concentration and dose. A polymerization mechanism is suggested that may involve a complexed monomer. Thus the increase of polymerization could be connected with the decrease of probability of degradational chain transfer with the complexed monomer molecule. It is also possible that the complexed allyl radicals produced by chain transfer are so much activated as to become able to open the double bond of the monomer molecule. (B.L.M.)

32199 RADIATION-INDUCED POLYMERIZATION BY FREE IONS. PART 1. POLYMERIZATION OF STYRENE UNDER ANHYDROUS CONDITIONS. Ueno, Katsuji; Williams, Ffranco; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). *Trans. Faraday Soc.*, 63: 1478-88 (June 1967).

The radioinduced ionic polymerization of bulk styrene was studied under extremely dry conditions. The rate R_p of polymerization increased with more rigorous drying of the monomer, and 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 bimolecular termination of free ions is indicated. The strong retardation of polymerization by scavengers of high proton affinity such as water, diethyl ether, ammonia, and trimethylamine in low concentrations (10^{-3} to 10^{-6} M) provides 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. Individual reaction steps for cationic and anionic mechanisms are discussed, 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)

32155 RADIATION INDUCED POLYMERIZATION BY FREE IONS. PART 2. ELECTRICAL CONDUCTIVITY MEASUREMENTS. Hayashi, Kanae; Yamazawa, Yuzo; Takagaki, Torao; Williams, Ffranco; Hayashi, Koichiro; Okamura, Seizo (Japanese Association for Radiation Research on Polymers, Osaka). *Trans. Faraday Soc.*, 63: 1489-1500 (June 1967).

The radioinduced specific electrical conductivities σ of rigorously dried cyclohexane, styrene, α -methylstyrene, and isobutyl vinyl ether were measured as a function of dose rate I . A dependence $\sigma \propto I^n$ was observed with n between 0.50 and 0.59, depending upon the system. It was confirmed that the absolute measurements of σ for cyclohexane are consistent with $G(\text{free ions}) \approx 0.1$, on the basis of reasonable values for the ionic mobilities. The mean lifetime τ (sec) of the ions in the stationary state is obtained directly from σ ($\text{ohm}^{-1}\text{cm}^{-1}$) by means of the relation $1/\tau = 3.6 \times 10^{12} \pi \sigma / \epsilon$, where ϵ is the dielectric constant; τ is about 50 msec at $I = 10^{15} \text{ eV cm}^{-2} \text{ sec}^{-1}$ for the monomer systems. At the same dose rate, the σ values for styrene and α -methylstyrene are lower than for cyclohexane by a factor of about 2. Results suggest that some charge carriers in the monomers have mobilities comparable to those in cyclohexane. The radioinduced conductivities of the hydrocarbon monomers are not appreciably affected by the addition of ethanol and ammonia, but are reduced by water. Some possible reasons for this behavior are examined. (auth)

25886 RADIATION-INDUCED POLYMERIZATION OF SOME RING COMPOUNDS IN THE LIQUID STATE. Ueno, Katsuji; Tsukamoto, Hiroshi; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). *J. Polym. Sci., Pt. B*, 5: 395-9 (May 1967).

The effects of ^{60}Co γ -radiation on the polymerizability of several ring compounds in the liquid state were investigated. Propylene oxide, ethylene sulfide, 3,3-bis(chloromethyl)oxetane (BCMO), 1,3-dioxolane, trioxane, diketene, tetrahydrofuran, and β -propiolactone were used. Rate and degrees of polymerization were very low. $G(-m)$ values were less than 10 and the polymers were oily, except ethylene sulfide. Diketene, β -propiolactone, and tetrahydrofuran were hardly polymerized. BCMO and trioxane were found very sensitive to water, polymerizing only after rigorous drying. A mechanism is offered. (P.C.S.)

23996 INFLUENCE OF TRIPHENYL-BETA-STYRYL-METHANE AND TRIMETHYL-BETA-STYRYL-LEAD ON THE POLYMERIZATION OF STYRENE. Danielczyk, B.; Orszagh, A. (Univ. of Warsaw). pp 479-82 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

In order to obtain some information on the role of the metal atom in the reactivity of metalloorganic compounds, a comparison was made of the behavior of triphenyl- β -styryl-lead (T-Pb) and the nonmetallic analog triphenyl- β -styryl-methane (T-Met) in the process of polymerization of styrene induced by γ radiation and by chemical initiators. Both with radioinduced and chemically initiated polymerization, T-Pb markedly accelerated the polymerization while T-Met had an inhibiting effect. Benzoyl peroxide was used as a chemical initiator. The accelerating effect of T-Pb is explained by the fact that the free radicals from the compound initiate additional chain growth. The inhibiting effect of T-Met is attributed to the inability of this substance to form chains due to steric hindrance caused by the presence of large aromatic substituents and to its stability to radiation with no radiolysis products being formed. (B.L.M.)

23995 POLYMERIZATION OF STYRENE AND α -METHYLSTYRENE BY IRRADIATION WITH SHORT PULSES OF FAST ELECTRONS. Schneider, Ch.; Swallow, A. J. (Univ., Cologne. Christie Hospital and Holt Radium Inst., Manchester, Eng.). pp 471-8 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The polymerization of styrene and α -methylstyrene by irradiation with short pulses of fast electrons was studied in both the pure state and in solutions. Absorption spectra were recorded. The kinetics of the decay of various intermediate species are discussed, and some attempts are made to establish identity of the intermediates and the role they play in the polymerization scheme. (B.L.M.)

24000 RADIATION INDUCED POLYMERIZATION OF FLUORO OLEFINS. Volkova, E. V.; Zimakov, P. V.; Fokin, A. V. pp 519-26 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The radioinduced polymerization of tetrafluoroethylene, trifluoroethylene, trifluorochloroethylene, vinylidene fluoride, vinyl fluoride, hexafluoropropylene, and perfluoroisobutylene were studied in the liquid phase at a dose rate of 10 RAD/sec at 20°C, except for the tetrafluoroethylene studies which were carried out at -78°C. A radiation chemical yield as high as 10^6 molecules/100 eV was noted for polymerization of tetrafluoroethylene, and the extraordinary high rate of polymerization is associated with the influence of the fluorine atom. Substitution of H for the F led to a decrease of polymerization rate, as did the substitution of a Cl atom for a F atom. From the experimental data, the fluoroolefins are arranged in the following series according to the decrease in polymerization rate: $CF_2 = CF_2 > CF_2 = CFH > CF_2 = CH_2 > CFH = CH_2 > CF_2 = CFCI > CF_2 = CF - CF_3 > CF_2 = C \begin{smallmatrix} \diagup CF_3 \\ \diagdown CF_3 \end{smallmatrix}$.

The results of kinetic studies showed that the kinetics of the radioinduced polymerization process are more complex than the kinetics of chemical polymerization. (B.L.M.)

32208 FLOW METHOD STUDY OF THE GAMMA-RAY-INDUCED POLYMERIZATION OF ETHYLENE. Kawakami,

Waichiro; Hosaki, Yoshihiko; Hagiwara, Miyuki; Machi, Sueo; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Guma). Ind. Eng. Chem., Process Design Develop., 6: 302-8 (July 1967).

The γ -induced gas-phase polymerization of ethylene in a flow system was carried out in a 1-liter continuously stirred tank reactor surrounded by a source of 54,000 Ci of ^{60}Co . The polymerization was studied quantitatively by measuring the reaction rate and the molecular weight of the polymer at a temperature of 30°C, a pressure of 400 kg per sq cm gage, a dose rate of 3.8×10^5 RAD per hr, and various flow rates. On increasing the flow rate from 300 to 3000 normal liters per hr, the reaction rate decreased from 0.51 to 0.31 C_2H_4 mole per liter of reactor-volume per hour, and the molecular weight decreased from 9.1 to 5.8×10^4 grams per gram-mole. Results indicated that a reaction in a flow system can be kinetically treated by the use of rate constants obtained in a batch system, and that the residence time of a polymer in the reactor is not equal to the value of reactor volume divided by the volumetric gas flow rate. This ratio increased from 0.32 to 2.40 with an increase in flow rate. (auth)

23915 RADIATION-INDUCED POLYMERIZATION OF ETHYLENE. Sawayanage, Shoichi; Machi, Sueo (Japan Atomic Energy Research Inst., Tokyo). Kagaku Kogyo, 17: No. 9, 21-4 (Sept. 1966). (In Japanese).

Results of the gamma-induced polymerization of ethylene are described. The G value for monomer consumption depended largely on the pressure and reached 3.4×10^4 at 400 kg/cm². The rate of chain-initiating reaction was directly proportional to the dose rate and the monomer concentration. The velocity of the chain propagation reaction was shown to be proportional to the second power of the monomer fugacity; the apparent activation energy of the reaction was -9 kcal/mole. The chain branching reaction was concluded to result from the displacement of free radicals in the growing polymer chains. Two types of the reaction apparatus, one with a 1 liter reactor and the other with a 10 liter reactor, were constructed for the polymerization of ethylene by continuous flowing of the monomer in the gamma field. The reaction conditions in the smaller apparatus were as follows: dose rate 3.8×10^5 rad/hr; reaction pressure 400 kg/cm²; reaction temperature 30°C; and monomer flow-rate 300 to 3000 N. liter/hr. The space-time yield of polymer was 9 to 14 g/liter hr and decreased with an increase in the flow rate of the monomer. The block diagram of the larger apparatus and some of the properties of the polymers obtained by this apparatus are also shown. (NSA of Japan)

23926 POLYMERIZATION OF ITACONIC ACID DERIVATIVES. Ishida, Shinichi; Saito, Shizuko (Asahi Chemical Industry Co., Ltd., Tokyo). J. Polym. Sci., Pt. A-1, 5: 689-705 (Apr. 1967).

The γ -ray-initiated polymerization of dimethyl itaconate was studied. Dimethyl itaconate was polymerized by γ irradiation at temperatures where the monomer does not polymerize thermally. As long as the monomer was kept in a liquid state, even at temperatures below the melting point, the polymerization took place. Itaconic anhydride was polymerized in the solid state with γ irradiation or benzoyl peroxide. The molecular weight of the polymer increased with time or yield and was greater than that of polymer obtained by other methods. Kinetic and crystallographic studies indicated that the γ -ray-initiated solid-phase polymerization is a first-order reaction with respect to monomer and the rate-determining step changes as the polymerization proceeds. (auth)

24304 RADIATION-INDUCED CATIONIC POLYMERIZATION OF ISOBUTENE. Ueno, K.; Hayashi, K.; Okamura, S. (Kyoto Univ.). J. Polym. Sci., Part B, 5: 569-73 (July 1967).

Radioinduced polymerization of isobutene dried by Na-K alloy and/or BaO was investigated. The range of polymerization was from liquid (-78°C) to glassy (-196°C) state. Rate of polymerization did not change with increasing temperature while the molecular weight decreased. Crystalline isobutene hardly polymerized at -196°C, but when 3-methylpentane was added as a glassy solvent at this temperature polymerization proceeded at a high rate. The glassy state polymerization was not sensitive to raising the temperature of the irradiated samples nor bleaching with uv and visible light at -196°C. Effects of NH_4^+ addition was negligible. Detailed kinetic studies are in progress. (P.C.S.)

24009 RADIATION INDUCED POLYMERIZATION AND COPOLYMERIZATION OF SOME NORBORNENE DERIVATIVES. Hardy, Gy.; Nyitrai, K. (Research Inst. for Plastics, Budapest). pp 613-20 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The γ -induced polymerization and copolymerization of the unsaturated cyclics, 5-carboxy-bicyclo-(2,2,1)-heptene-(2) (norbornenecarboxylic acid), norbornenedicarboxylic acid monoallyl ether, and norbornene dicarboxylic acid monopropyl ester were investigated in the liquid state at 65, 55, and 46.5°C with dose rates between 0.49 and 1.05×10^5 R/hr. The kinetics are of a linear character; the polymerization rate is proportional to the first power of the dose rate; and the polymerization is inhibited by the addition of certain chemicals. From spectroscopic analysis, it was concluded that carboxylic acid polymerizes by opening of the ring but with preservation of the double bonds. The monopropyl ester does not polymerize in the solid state but forms a solid solution with the allyl ester and reduces the polymerization rate of the latter by physical hindrance. (B.L.M.)

23999 RADIATION POLYMERIZATION AND COPOLYMERIZATION OF VINYL FLUORIDE. Usmanov, Kh. U.; Yulchibaev, A. A.; Dordyain, G. S.; Yuldasheva, Kh. (Tashkent State Univ.). pp 511-17 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

A high radiation-chemical yield dependent on γ dose rate was measured for vinyl fluoride polymerization. The yield ranged from 0.5 to 4.5×10^4 molecules/100 eV, and an expression is given relating yield to dose rate. The data indicate that chain polymerization termination does not take place by chain transfer at all. The inhibiting effect of various concentrations of acetylene and O_2 on the polymerization was investigated. The polymerization rate in solutions of benzene and CCl_4 was considerably lower than in the pure state. The copolymerization of vinyl fluoride with vinyl chloride, vinyl acetate, and acrylonitrile was studied at various dose rates. Results of studies of the important properties of the polymers and copolymers are presented. (B.L.M.)

21991 THE REACTION OF ACETYLENE WITH γ RADIATION UNDER PRESSURE. II. Yashiro, Dairokuro; Naito, Teruyuki. Tokyo Kogyo Shikensho Hokoku, 62: 91-5 (Mar. 1967). (In Japanese).

Acetylene was polymerized by irradiation with γ rays from ^{60}Co under pressure in the range from 3.5 to 16 atm (absolute) and in the temperature range from 30 to 100°C. The value of $G(-C_2H_2)$ for the over-all reaction was nearly constant in this range, (≈ 80), but $G(C_6H_6)$ decreased from 15 to 6 with increasing acetylene pressure, and $G(-C_2H_2)$ for polymer formation increased from 25 to 60 with increasing pressure. The apparent activation energies for both reactions were very small, and the rates were proportional to the 0.8th order of dose rate. $G(C_6H_6)$ was not influenced by variation of surface-volume ratio of reaction vessel. $G(\text{diacetylene})$ was less than 1 and approximately proportional to $G(C_6H_6)$ in this range. (auth)

24031 RADIATION INDUCED POLYMERIZATION OF ALIPHATIC AND ALICYCLIC OXIDES. Cordischi, D.; Mele, A.; Somogyi, A. (CNEN, Rome, Univ., Rome). pp 483-91 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The radioinduced polymerization of aliphatic and alicyclic oxides was studied in both liquid and solid state for a number of monomers. Some monomers do not give polymers, even with high radiation doses, others polymerize giving low molecular weight polymers, and some alicyclic epoxides and tetrafluoroethylene oxide give high polymers. Tetrafluoroethylene oxide polymerizes only if irradiated in the solid state, but aliphatic epoxides have no tendency to polymerize. The reaction mechanism of the polymerization of 1,2-cyclohexene oxide was studied in detail. The addition of H_2O and NH_3 drastically reduced the rate of polymerization. From the kinetic data, expressions were derived for the reciprocal of the polymerization rate and of the degree of polymerization. The evidence gathered from the studies of the monomers strongly favors a cationic mechanism of polymerization. (B.L.M.)

32207 RADIATION-INDUCED BULK POLYMERIZATION OF MALEIMIDE. Kagiya, Tsutomu; Izu, Masatsugu; Kawai, Shunzo; Fukui, Kenichi (Kyoto Univ.). J. Polym Sci., Pt. A-1, 5: 1415-23 (June 1967).

Radioinduced bulk polymerization of maleimide in both solid and liquid states was studied. Benzoquinone inhibited the liquid-state polymerization and retarded solid-state polymerization. The results of an ESR study showed that solid monomer irradiated at 61°C gave a spectrum, the concentration of which slowly decreased without changing the shape. The radical detected at 61°C was shown not to be the main propagating species. Overall-rate polymerizations in the liquid and solid states were expressed, respectively, by first-order and zero-order rate equations with respect to the concentration of monomer. The overall-rate constants in liquid and solid states were proportional to $I^{0.8}$ and $I^{1.0}$, respectively. (auth)

24012 RADIATION POLYMERIZATION OF ACENAPHTHYLENE. Muller, J. Cl. pp 643-7 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Radioinduced polymerization of acenaphthylene was studied in both the liquid and solid states. The solid-state polymerization was inhibited by air at 28°C. Conversion versus irradiation time curves were prepared. Effects of temperature and dose rate were determined. (M.C.G.)

Copolymerization

45182 POLYMERIZATION METHOD FOR CYCLIC ETHERS IN THE PRESENCE OF MALEIC ANHYDRIDE OR ITS HALIDE DERIVATIVES. (to Japanese Association for Radiation Research on Polymers). British Patent 1,085,805. Oct. 4, 1967. Priority date Nov. 8, 1963, Japan.

A method of producing a polymer and copolymer of polyether is described. Polymerization of cyclic ether in the presence of maleic anhydride or its halide derivatives is carried out by irradiation with ionizing or ultraviolet radiations or by the action of a free radical polymerization initiator, such as benzoyl peroxide. The polymers thus obtained consist mainly of polyether and in some instances contain a small amount of maleic anhydride in the chain and/or the terminal unit of the molecule. (J.G.B.)

36041 γ -RAY INDUCED TELOMERIZATION REACTIONS BETWEEN ALLYLIC COMPOUNDS AND CARBON TETRACHLORIDE. IV. REACTIONS OF ACETATES OF METHYL-SUBSTITUTED ALLYLIC ALCOHOLS. Okubo, Masao (Government Industrial Research Inst., Nagoya, Japan). Bull. Chem. Soc. Jap., 40: 1672-7 (July 1967).

The γ -induced telomerization of allyl, α -methallyl, α,α -dimethylallyl, and β -methallyl acetates with carbon tetrachloride was carried out in order to compare the effects of methyl substituents. In the first 3 the effect of successive methyl substitution on the allylic α -position showed exactly the same regularity as to the effects on the velocities of $C=C$ consumption, the telomer production ratios, and their change with the initial concentration of esters. The β -methyl substituent retarded the velocity of the $C=C$ consumption to the utmost extent, it retarded telomer production ratio only a little, and it depressed the effect of ester concentration. Together with these observations, the amounts of hydrogen chloride generated during irradiation are discussed in relation to the degradative chain transfer mechanism. (auth)

23992 RADIOLYTIC FORMATION OF POLYMERS FROM MIXTURES OF HEXAFLUOROBENZENE WITH PERFLUOROCYCLOHEXENE AND PERFLUORONONANE. Khranchenkov, V. A. pp 443-7 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The effect of variation of concentration of hexafluorobenzene on the neutron- and γ -induced polymeric yields in mixtures of hexafluorobenzene with perfluorocyclohexane and perfluorononane was evaluated. The polymeric yield from the mixtures of hexafluorobenzene with n-perfluorononane exceeded the yield obtained from either of the components and led to the conclusion that hexafluorobenzene is an agent stimulating polymerization. However, mixtures of hexafluorobenzene with perfluorocyclohexane exhibited a decreasing polymeric yield with increasing electron fraction of the latter, and the yields were considerably below expected theoretical values. No conclusions were drawn concerning the mechanisms of these polymerizations. (B.L.M.)

34293 INFLUENCE OF ADDITION OF OLEFINS ON THE ALTERNATING COPOLYMERIZATION OF CARBON MONOXIDE AND ETHYLENIMINE BY AZOBISISOBUTYRONITRILE OR BY γ -RAY IRRADIATION. Kagiya, Tsutomu; Maruta, Isao; Ichida, Taizo; Narisawa, Shizuo; Fukui, Kenichi (Kyoto Univ.). J. Polym. Sci., Part A-1, 5: 1645-58 (July 1967).

The alternating copolymerization of carbon monoxide and ethylenimine to give poly- β -alanine could be initiated by γ -irradiation but hardly by α,α' -azobisisobutyronitrile (AIBN). It was found that in the case of the addition of olefin, this system could be copolymerized even by AIBN and that, in the γ -ray copolymerization of carbon monoxide and ethylenimine, the addition of olefin brought about an increase in the copolymer yield. No difference was observed between the nature of copolymers obtained by AIBN and those obtained by γ -irradiation, except in the system carbon monoxide-ethylenimine-ethylene. An increase in the amount of reacted olefin gave rise to an increase in copolymer yield. The melting points of the copolymers were in the range 295 to 335°C. The infrared spectra, x-ray diffraction diagrams, and NMR spectra of the copolymers were almost identical with that of poly- β -alanine obtained by the hydrogen-migration polymerization of acrylamide. Paper chromatographic analysis of the hydrolysis product of the copolymer showed the existence of β -alanine, ethylamine, and δ -aminovaleric acid homolog in the products. From these results, it was concluded that terpolymerization of carbon monoxide, ethylenimine, and olefin took place in the presence of AIBN or γ -irradiation, which gave a crystalline solid copolymer containing the units of nylon 3 and nylon 5. A mechanism of this copolymerization was proposed on the basis of these results. (auth)

24002 PREPARATION OF THERMALLY STABLE COPOLYMERS OF POLYFORMALDEHYDE BY IONIZING RADIATION. Hodekovich, L. (Inst. of Chemical Industry, Sofia). pp 535-8 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Probable mechanisms are proposed for the formation of radicals by irradiation of polyformaldehyde (PFA), which can account for the formation of block-, graft-, and inter-polymers. The depolymerization of the PFA with propylene oxide, styrene, and methyl methacrylate as monomers was induced by γ irradiation. The relative viscosity before and after irradiation, the melting point, the yield, and the kinetic curves of the decomposition of the copolymer at 232°C in air were all studied. On the basis of the experimental results it was assumed that on irradiation of the PFA in the presence of monomers, cleavage of the chain occurs with formation of block polymers. (B.L.M.)

24023 ROLE OF CROSSLINKS IN THE RECOMBINATION OF RADICALS IN IRRADIATED ELASTOMERS. Kuzminskii, A. S.; Kvashenko, Ya. Ya.; Fedoseeva, T. S. (Scientific-Research Inst. of Rubber Industry, Moscow). pp 741-8 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The effect of crosslinks on the radical recombination kinetics at the phase-state change and the effect of crosslinks on the reaction rates of free radicals over a range of temperature from -196°C to room temperatures were investigated using γ -irradiated poly(dimethyl siloxane). The ESR method was used for the experimental observations. Radical decay kinetics were found to depend on the nature of crosslinks and on the dimensional network density for the temperature range studied. Below the phase transition interval radical recombination in natural rubber hydrocarbons occurred as a result of the free valency transmission along the molecular chain. In the phase transition range, the radicals recombine by diffusion in the molecular chain parts, and the rate of the process depended on the number of crosslinks and on the radical distribution corresponding to these links. In the temperature range above the phase transition interval, the radicals decayed with a low rate that depended on the steric difficulties of their recombination. (B.L.M.)

23935 EFFECT OF GAMMA-RADIATION ON PROPERTIES AND STRUCTURE OF ETHYLENE-PROPYLENE COPOLYMERS. Orszagh, Andrzej; Obloj, Jozef (Univ., Warsaw. Inst. of Heavy Organic Synthesis, Blachownia Slaska, Poland). *Rocz. Chem.*, 41: 617-25(1967). (In Polish).

In a study of the effects of gamma radiation on ethylene-propylene copolymers it was found that simultaneously with cross-linking a degradation reaction occurs. Degradation increased with increasing propylene content in the macromolecule. The effects of dose and propylene content on the gel formation process were examined. The G_H was determined and found to decrease with increase of dose or propylene content. The disappearance of primary unsaturated bonds is discussed. (D.H.M.)

23998 GAMMA-RAY INDUCED COPOLYMERIZATION OF ETHYLENE AND CARBON MONOXIDE. Munari, S.; Russo, S.; Rossi, C. (Univ., Genoa). pp 501-9 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The established technique of γ -induced copolymerization of ethylene and CO at room temperature was applied to very pure monomers in a study to clarify the kinetic features of the process. The addition of CO to ethylene greatly increased the polymer yield in the virtual absence of O_2 ; however, even at low concentrations the presence of O_2 inhibited the ethylene polymerization. An overall kinetic scheme is suggested for the copolymerization process. (B.L.M.)

24025 SIMULTANEOUS CROSSLINKING AND DEGRADATION OF POLYMERS IN ORGANIC SOLUTIONS BY GAMMA RAYS. Schnabel, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). pp 757-63 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Investigations were carried out to determine the fraction of crosslinking and degree of degradation due to γ irradiation of polymers in organic solutions by studying the behavior of poly(dimethylsiloxane) in toluene. The dependence of the fraction of crosslinking and degree of degradation on polymer concentration was lower than some critical concentration. The results indicated that there is a transition from molecular crosslinking to the main-chain scission at the critical concentration. Expressions for the values of the fraction of crosslinked and degraded base units/MRAD were arrived at by combining measurements of the weight and number average molecular weight of the irradiated polymer. (B.L.M.)

38966 EFFECT OF POLYFUNCTIONAL MONOMERS ON RADIATION CROSSLINKING OF POLYETHYLENE. Egorova, Z. S.; Karpov, V. L.; Leshchenko, S. S.; Mitrofanova, L. V.; Finkel, E. E. (Scientific-Research Physical-Chemical Inst., Moscow. Scientific-Research Inst. of the Cable Industry, Moscow). *Vysokomol. Soedin.*, Ser. A, 9: 1451-8(July 1967). (In Russian).

The effect of triallyl cyanurate (TAC), diallyl maleate (DAM) and allyl methacrylate (AMA) on polyethylene (PE) crosslinking and polyfunctional monomer (PFM) introduction were studied by means of extraction and IR spectroscopy. All tested PFM was shown to effectively sensitize radiation PE crosslinking in air (except DAM) and in an inert gas atmosphere their action was effective at doses not higher than 50 MRAD. Not only PFM addition to polymer radicals occurred during irradiation but partial polymerization also occurred. The PFM efficiency depended to a considerable extent on the method of their introduction into PE. Thermal treatment caused polymerization of PFM and decreased its efficiency. (auth)

24001 RADIATION INDUCED COPOLYMERIZATION OF METHACRYLIC ACID WITH METHACRYLAMIDE. Mousaev, U. N.; Tillaev, R. S.; Usmanov, Kh. U. (Tashkent State Univ.). pp 527-33 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The γ -induced polymerization of methacrylic acid and methacrylamide in water solutions was studied at radiation doses and intensity varied over a wide range and at various concentrations of monomer solutions. An increase in either irradiation dose or concentration of initial monomer solution were found to result in increased polymerization. Various characteristics and properties of the copolymers were investigated. The relation of characteristics of the copolymer to conditions of its formation are discussed. (B.L.M.)

30461 RADIOINDUCED COPOLYMERIZATION OF STYRENE AND SULFUR DIOXIDE. Kuri, Zenichiro; Ito, Masayuki (Nagoya Univ., Japan). *Kogyo Kagaku Zasshi*, 69: 1066-9(May 1966). (In Japanese).

Radioinduced copolymerization of styrene and SO_2 was studied between room temperature and $-196^\circ C$. The monomer ratio of the polysulfone obtained at room temperature was 2:1 (styrene to sulfur dioxide), and the polymer yield increased with the styrene concentration in starting materials. The monomer ratio at $-78^\circ C$ was about 1:1 and the yield had a maximum at a 1:2 mixture. If a considerable amount of methylene chloride or a small amount of DPPH was added, the yield of polysulfone decreased and polystyrene was formed, which suggests an ionic mechanism. (NSA of Japan)

Graft Polymerization

40916 RADIATION GRAFT-COPOLYMERIZATION OF GLYCIDYL METHACRYLATE TO POLYETHYLENE. Kabanov, V. Ya.; Kazimirova, N. M.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Moscow). *Vysokomol. Soedin.*, 9: 1758-62(Aug. 1967). (In Russian).

Graft copolymers of polyethylene with polyglycidyl methacrylate containing epoxy groups were prepared by γ -polymerization. IR spectra were studied. The kinetics of radiation grafting at different dose rates and temperature was studied. At a certain critical temperature the reaction rate decreased sharply. ESR spectra of glycidyl methacrylate and poly(glycidyl methacrylate) showed their shape and radiation yield to be close to poly(methyl methacrylate). The vapor-phase grafting resulted in low yield possibly due to increased temperature of the samples. (auth)

24018 EFFECT OF MONOMER STRUCTURE ON THE EFFICIENCY OF RADIATION INDUCED GRAFT COPOLYMERIZATION. Zurakowska-Orszagh, J. (Univ. of Warsaw). pp 693-701 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The γ -induced grafting efficiency in comparison to simultaneous homopolymerization under identical experimental conditions was studied for the grafting of the following monomers onto polyethylene: acrylic acid, methacrylic acid, methyl acrylate, methyl methacrylate, butyl acrylate, butyl methacrylate, acrylamide, methacrylamide, N-phenyl acrylamide, and N-phenyl methacrylamide. Peroxide-initiated graft polymerization was used as a basis for comparison. Higher grafting efficiencies and lower homopolymerization were noted for all the methacrylic series, except methyl methacrylate, than for the acrylic series; and in all cases radioinduced grafting gave higher yields than those measured for chemical initiators. There was some indication that the solubility of the polymers influences the grafting efficiency since highest grafting yields were obtained with methacrylic acid, which gave polymers soluble in methanol and the lowest grafting yields with methyl acrylamide, which precipitates after polymerization. (B.L.M.)

25926 PROCESS FOR PRODUCING HIGH MOLECULAR WEIGHT POLYOXYMETHYLENE. (to Asahi Kasei Kogyo Kabushiki Kaisha). British Patent 1,067,358. May 3, 1967. Priority date Dec. 28, 1963, Japan.

A process for producing high-molecular-weight polyoxymethylene of high purity consists of subjecting low-molecular-weight polyoxymethylene or paraformaldehyde having a high water content to ionizing radiation or ultraviolet radiation in a closed system to produce polyoxymethylene of a higher molecular weight and usually a lower water content. This higher-molecular-weight polyoxymethylene is then subjected to pyrolysis to yield a formaldehyde of very high purity and very low moisture content, which is then polymerized by a conventional method to yield the polyoxymethylene having improved thermal stability and good molding properties. (B.L.M.)

42971 GRAFT-COPOLYMERIZATION OF N-VINYLPHTHALIMIDE TO POLYETHYLENE BY γ -RAY RADIATION. Murata, Kenichi (Government Industrial Research Inst., Osaka). *Bull. Chem. Soc. Jap.*, 40: 2187-9(Sept. 1967).

The γ radioinduced graft polymerization of N-vinylphthalimide to polyethylene was studied. The grafted film was reacted with n-propylamine at room temperature, and the process of the reaction traced by infrared spectra. Results of dyeing the grafted film as well as the amine-treated film with direct, acid, basic, and dispersed dyes are reported. The amine-treated films were dyed more easily than the original copolymer. (J.G.B.)

25876 PRODUCTION OF GRAFT COPOLYMERS BY IRRADIATION OF MIXTURES OF POLYOXYETHYLENE (GLYCOL) AND STYRENE. Wagner, Joseph; Marchal, Jean (Centre de Recherches sur les Macromolécules, Strasbourg). *Compt. Rend., Ser. C.*, 264: 1263-6 (Apr. 10, 1967). (In French).

Graft copolymers can be obtained by irradiation of degassed mixtures of a vinyl polymer and a vinyl monomer. It was found that this procedure gives satisfactory results when it is applied to a mixture of polyoxyethylene [glycol] and styrene. Some preliminary results are given concerning a study of the yield of the reaction as a function of the temperature of irradiation and the composition of the irradiated mixtures. (tr-auth)

30456 ABS RESINS BY RADIATION-INDUCED GRAFT COPOLYMERIZATION. Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture). *Genshiryoku Kogyo*, 12: No. 9, 38-42; 79 (Aug. 1966). (In Japanese).

The preparation of several kinds of ABS resin (acrylonitrile-butadiene-styrene copolymers) was attempted by irradiating the emulsions of mixed polymers and monomers in various combinations with ^{60}Co γ rays. The combination most extensively studied was acrylonitrile and styrene monomers emulsified in polybutadiene latex. The velocity of monomer conversion was directly proportional to the dose rate. The effect of the emulsifier used was investigated. The mechanical properties of the resulting ABS polymer were not inferior to those of commercial ABS resins. (NSA of Japan)

30460 VAPOR-PHASE GRAFT POLYMERIZATION ON POLYMERS PRE-IRRADIATED IN AIR. EFFECT OF COEXISTENT GASES. Oda, Eisuke; Hoshino, Nobuo (Furukawa Electric Co., Ltd., Japan). *FAPIG* (Tokyo), No. 41, 124 (July 1966). (In Japanese).

A study was made on the effect of coexistent gases on the vapor-phase graft polymerization of styrene onto low-density polyethylene pre-irradiated in air. The pre-irradiation was done with ^{60}Co γ rays at the dose rate of 5.5×10^4 R/hr to the total dosage of 2.75 MR. When the coexistent gas was an inert gas such as N_2 or Ar with low solubility in the polymer, the grafting ratio decreased or increased, depending on whether the reaction velocity was diffusion-controlled or reaction-controlled. When the coexistent gas was the vapor of benzene, a good solvent for polystyrene and a good swelling agent for polyethylene at the reaction temperature, the grafting was accelerated at low benzene concentrations (below 15%) but retarded at high benzene concentrations. This retarding effect may be caused by the lowering of styrene concentration due to accumulation of benzene in the polymer, and also by bimolecular termination between the free radical terminals in the swelled polymer matrix. The presence of a trace amount of CCl_4 retarded the reaction; this may be explained by considering the chain transfer. The presence of a small amount of methanol, a poor solvent for both polyethylene and polystyrene, accelerated the reactions; this may be explained by the gel effect produced by the suppression of the mobility of the free radical terminals in the presence of methanol. (NSA of Japan)

24014 RADIATION GRAFTING IN THE VITREOUS STATE AT LOW TEMPERATURE. Chapiro, A.; Jendrychowska-Bonamour, A. M. (CNRS, Bellevue, France). pp 659-63 of *Proceedings of the Second Tihany Symposium on Radiation Chemistry*. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Studies of γ -induced grafting of acrylonitrile, styrene, and isobutylene onto poly(vinylchloride) (PVC) films at -78 and -196°C when the mixtures were in the form of glasses are reported. The reactions were found to proceed by either free radical (acrylonitrile) or cationic mechanism (isobutylene and presumably styrene). Since the graft polymerization was found to proceed by an ionic mechanism, it seems certain that ionic species resulting from the irradiation of PVC films can initiate polymerization and that the monomer becomes chemically bound to the initiating polymeric ion. (B.L.M.)

24016 GAMMA RADIATION INDUCED GRAFT COPOLYMERIZATION OF STYRENE ONTO POLY(VINYL CHLORIDE). Langner, H.; Wuckel, L. (Institut fuer Metallphysik und Reinstmetalle, Dresden). pp 677-83 of *Proceedings of the Second Tihany Symposium on Radiation Chemistry*. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The effects of stabilizers in the polyvinyl chloride film (PVC), grafting time, grafting temperature, and pre-irradiation dose on the γ -induced grafting of styrene onto PVC were investigated. The grafting process was found to be of the free radical type, and the course of grafting was identical in each experiment: an initial rapid increase followed by a slower process that proceeds at a constant rate up to fairly high conversions. A possible reaction scheme is that reactive monomer radicals are formed by thermal homopolymerization, which forms secondary radicals on the PVC chain by transfer reaction. (B.L.M.)

30481 METHOD FOR THE PRODUCTION OF SHEETS OR FILMS OF FOAMED POLYETHYLENE. Asaoka, Masao (to Hitachi Chem. Ind. Co.). Japanese Patent 1966-6278. Apr. 4, 1966. Filed Mar. 22, 1963.

A method for the production of sheets or films of foamed polyethylene includes blending polyethylene with a foaming agent having a decomposition temperature higher than the melting point of the polyethylene, fabricating the mixture into sheets or films, crosslinking the polyethylene by irradiating the sheets or films with ionizing radiation, and thermally decomposing the foaming agent contained in the sheets or films. The over-all procedure can be continuous, and gives fairly thin sheets or films very readily. (NSA of Japan)

30463 VAPOR-PHASE GRAFT POLYMERIZATION ON POLYMERS PREIRRADIATED IN AIR. PART I. COMPARISON OF VARIOUS METHODS OF GRAFTING. Oda, Eisuke; Hoshino, Nobuo (Furukawa Electric Co., Ltd., Japan). *Furukawa Denko Jiho*, No. 40, 40-4 (Dec. 1965). (In Japanese).

Various methods for graft polymerization with ionizing radiation were compared and problems involved in the methods are discussed on the basis of experimental data. In graft polymerization by pre-irradiation in air, the peroxide contents of polyethylene films irradiated at low dose rates (10^4 to 10^5 R/hr by ^{60}Co γ rays) and at high dose rates (10^5 to 10^8 RAD/sec by electrons from linear accelerator) were estimated from carbonyl absorption in the infrared spectra. The difficulty in the peroxidization of thick films when irradiated at high dose rates showed that peroxidization was controlled by diffusion of O_2 in the films. The apparent activation energy for the decomposition of the peroxide formed in the polyethylene was calculated from the relative rate of grafting, which was a little over 20 kcal/mol. The grafting velocity of polymers pre-irradiated in air was generally smaller in vapor-phase grafting than in the liquid-immersion grafting, but when the grafting was done in saturated monomer vapor, the velocity was the same as in liquid-immersion grafting. In the vapor-phase grafting of styrene onto polyethylene pre-irradiated in air, the velocity of grafting was proportional to the third power of the pressure of the monomer vapor when the pressure was fairly low so that the process was diffusion-controlled. (NSA of Japan)

24013 GRAFTING OF METHYL METHACRYLATE AND ACRYLONITRILE ONTO PRE-IRRADIATED POLY(VINYL CHLORIDE) FILMS. Chapiro, A. (CNRS, Bellevue, France); Mankowski, Z. pp 649-57 of *Proceedings of the Second Tihany Symposium on Radiation Chemistry*. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The kinetics of grafting methyl methacrylate and acrylonitrile onto films of pre-irradiated poly(vinyl chloride) (PVC) either in a vacuum or in air were investigated. The PVC films were pre-irradiated with γ irradiation and the grafting was achieved by heating for various periods of time at different temperatures. The data indicate that the reaction for grafting onto vacuum-irradiated PVC films is initiated by trapped radicals. The rate of grafting was reduced at elevated temperatures; and since the reaction and growth of the grafted branches occur during the swelling of the film, the elevated temperature allows a significant diffusion of the polymer molecules so that radical-radical recombination and chain termination does indeed occur. Several conclusions concerning the preoxidation of PVC films are drawn and related to the grafting onto air-irradiated films. (B.L.M.)

24015 DIRECT RADIATION AND SPONTANEOUS GRAFTING OF STYRENE ONTO POLYOLEFINS. Dobo, J. (Research Inst. for Plastics, Budapest); Czvikovszky, T.; Ranogajec, F. pp 665-76 of *Proceedings of the Second Tihany Symposium on Radiation Chemistry*. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Studies were made of the direct grafting of styrene onto polyethylene and polypropylene, and the spontaneous (thermal) grafting of styrene onto polyethylene, and the results are compared and correlated with the thermal homopolymerization of styrene. The rate of the direct radiation grafting of styrene onto both polyolefins was constant and dependent on the 0.5th power of the dose rate. The rate of initiation for both the direct radiation grafting and for spontaneous grafting are calculated, and the thermal polymerization inside the polyolefin films fully accounts for the spontaneous grafting. It was concluded that the diffusion of the monomer is rapid and that the grafting reaction is controlled by polymerization kinetics rather than by the chemical structure of the base polymer. (B.L.M.)

21999 CHEMICAL MODIFICATION OF FIBERS BY THE GRAFT COPOLYMERIZATION OF REACTIVE MONOMERS. I. GRAFT COPOLYMERIZATION OF ACRYLAMIDE AND GLYCIDYL METHACRYLATE ONTO COTTON FABRIC AND CROSSLINKING OF THE GRAFT COPOLYMERS. Tsuji, Waichiro; Ikeda, Tetsuo; Umatani, Mikiko; Kadono, Yoriko (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 45: 77-86 (Jan. 1967).

Reactive monomers such as acrylamide and glycidyl methacrylate were graft copolymerized on cotton fabric by ^{60}Co γ -irradiation. Crosslinking was then introduced to these grafted cottons by use of the reactive side groups. The crease recovery and some tensile properties of the grafted and crosslinked cotton were examined. With appropriate crosslinking, dry and wet crease recoveries of the grafted cotton were improved for either acrylamide or glycidyl methacrylate. Though the tensile strength of the grafted cotton fabric was decreased by crosslinking, the tensile damage of cotton resulting from crosslinking was remarkably decreased by the grafting. (auth)

22000 CHEMICAL MODIFICATION OF FIBERS BY THE GRAFT COPOLYMERIZATION OF REACTIVE MONOMERS. II. GRAFT COPOLYMERIZATION OF ACRYLIC ACID ONTO POLYPROPYLENE AND POLYVINYL CHLORIDE FIBERS. Tsuji, Waichiro; Ikeda, Tetsuo; Kuorkawa, Yoko (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 45: 87-96 (Jan. 1967).

Some properties of polypropylene and polyvinyl chloride fibers grafted with acrylic acid using ^{60}Co γ -irradiation were examined. Though the tensile properties of grafted and aftertreated fibers were nearly equal to the original fiber, heat shrinkage of the fibers was remarkably decreased by acrylic acid grafting and aftertreatment with inorganic metal salts. Tensile properties at elevated temperatures were not improved as much as expected from the decrease of heat shrinkability. By acrylic acid grafting and Na salt aftertreatment, moisture regain increased and frictional electricity decreased, while wet tensile strength, heat settability, and dimensional stability in wet state were almost unchanged. (auth)

24019 RADIATION GRAFTING OF VINYL PYRROLIDONE ON ACETYL CELLULOSE. Usmanov, Kh. U.; Tillaev, R. S.; Tashmuhamedov, S. A. (Tashkent State Univ.). pp 703-8 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Graft copolymers of acetyl cellulose and vinyl pyrrolidone were synthesized by γ irradiation of the monomer in the absence of O_2 , extraction of the homopolymer from the reaction mixture with water, and extraction of the ungrafted acetyl cellulose with acetone to leave the graft polymers. The graft copolymers prepared in this manner were used to determine the solubility of copolymers in general prepared by ionizing radiation. The physico-chemical properties of samples of the copolymers prepared at different radiation doses and at different monomer concentrations are tabulated. The data indicate that not only the nature of the polymer components but also the effect of γ irradiation on the components determines the properties of the radiation-synthesized graft copolymer. (B.L.M.)

24022 HYDROPHILIZATION OF POLYESTER FIBRES BY RADIATION GRAFT COPOLYMERIZATION. Zielinski, W.; Achmatowicz, T.; Robalewski, A. (Inst. of Nuclear Research, Warsaw). pp 733-9 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Poly(ethylene terephthalate) was graft polymerized with 4-vinylpyridine and with acrylic and methacrylic acid using γ radiation to improve the moisture and dye absorption of the fibers from dye baths. The addition of Ni^{2+} and Fe^{2+} ions increased the degree of grafting. The tensile strength of the fiber grafted by the post-effect method was greatly reduced at the expense of improved dyeability. However, valuable hydrophilic properties that improved the absorption of both moisture and dyes with very little accompanying loss of tensile strength were found to result from the simultaneous irradiation and grafting of the fiber at high temperature from aqueous solutions of acrylamide or methacrylamide containing mono- or polycarboxylic acids. (B.L.M.)

24020 RADIATION GRAFTING OF ACRYLONITRILE ON CELLULOSE FROM THE VAPOR PHASE. Usmanov, Kh. U.; Asisov, U.; Sadykov, M. U. (Inst. of Chemistry, Tashkent). Tech. of Cotton Cellulose, Tashkent). pp 709-14 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Results of studies of γ -induced vapor-phase grafting of acrylonitrile onto cellulose indicated that increasing relative humidity of the atmosphere where grafting takes place favors higher grafting yields. The influence on the mechanical properties of the graft copolymer of irradiation dose, irradiation intensity, residual pressure on the system after degassing and freezing of acrylonitrile, and micro-organisms were investigated. The results indicated that vapor-phase grafting is an effective method for the modification of cellulose properties without the formation of by-products. (B.L.M.)

22002 RADIATION-INDUCED GRAFT COPOLYMERIZATION OF METHYL METHACRYLATE ONTO POLY(VINYL ALCOHOL) FILM IN THE PRESENCE OF CHAIN TRANSFER AGENTS. Sakurada, Ichiro; Ikada, Yoshito; Yamaoka, Takashi (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 45: 1-11 (Jan. 1967).

The grafting of methyl methacrylate onto poly(vinyl alcohol) by pre-irradiation techniques was studied in the presence of various chain transfer agents such as *n*-butyl mercaptan, triethylamine, and trichloroethylene. It was found that the length of grafted side-chain could be reduced by the use of these chain transfer agents. Chain transfer constants estimated from the change in degree of polymerization of homoPMMA formed during the grafting and PMMA obtained by the usual catalytic polymerization were in good agreement. Not only percent grafting and graft efficiency, but also overall rate of polymerization were decreased with increasing concentration of chain transfer agents. From the results it was concluded that the growing radicals on the grafted side-chain were transferred to the chain transfer agent and, that the radicals derived from chain transfer agent partially deactivated the active species for grafting besides re-initiation of the homopolymerization. The grafting was also carried out in the presence of *p*-benzoquinone, which is known as a retarder, and some discussion was given on the result obtained. (auth)

Solid State

45174 RADIATION-INDUCED SOLID-STATE POLYMERIZATION IN BINARY SYSTEMS. IV. SOLID-STATE POLYMERIZATION IN THE GLASSY PHASE. Kaetsu, Isao; Tsuji, Kozo; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). J. Polym. Sci., Part A-1, 5: 1899-1909 (Aug. 1967).

The radioinduced polymerization of glass-forming systems containing monomers was investigated. It was found that irradiation below the second-order transition temperature T_g of the systems causes no in-source polymerization but causes a rapid postpolymerization on warming above the T_g after initial irradiation below the T_g . The post-polymerization was followed by differential thermal analysis and ESR spectral analysis. It is caused above the T_g by the release of peroxy radicals trapped below the T_g , and its rate is proportional to the irradiation dose to some extent, often is explosively high, and brings about a remarkably large temperature rise by accumulation of polymerization heat. Irradiation above the T_g causes rapid in-source polymerization which is accelerated by the high viscosity of the monomeric system between T_g and T_i (WLF temperature) compared to crystal or ordinary solution polymerization. The temperature dependence of the in-source polymerization of glassy systems shows a peak between the T_g and T_i , which may be the result of competing effects of the rate increase by the decreased termination near T_g and the rate decrease by the decreased propagation caused by the diffusion prevented near the T_g . The degree of polymerization was also investigated. The temperature dependence of the degree of polymerization of the polymers obtained by in-source polymerization shows a peak similar to that of the temperature dependence of conversion. Unusually large values of the Huggins constant k' are noted between T_g and T_i . The degree of polymerization of the polymer obtained by post-polymerized increases with the increase of irradiation dose and the polymerization rate; this may be the result of decreased chain transfer to nonpolymerizable components. (auth)

40926 SOLID-STATE RADIATION POLYMERIZATION OF TRISELENANE TO POLENOMETHYLENE. Carazzolo, Gianalvise; Mammi, Mario (Societa Montecatini-Edison, Varese, Italy. CNR, Padua). J. Polym. Sci., Part C, No. 16, 1521-7 (1967).

From International Symposium on Macromolecular Chemistry, Prague, Aug. 30-Sept. 4, 1965. See CONF-650801-(Pt.3).

Triselenane, the cyclic trimer of selenoformaldehyde (CH_2Se)₃, subjected to gamma irradiation, was partially converted into crystalline polyselenomethylene (CH_2Se)_n. The solid-state polymerization was proved to take place in two directions, parallel to the two [hh0] and [h $\bar{h}$ 0] diagonal axes in the ab plane of the trimer orthorhombic unit cell. The polymer crystal lattice is orthorhombic with $a = 5.37 \text{ \AA}$, $b = 9.03 \text{ \AA}$, $c = 4.27 \text{ \AA}$, and space group $\text{P}2_12_12_1$; the polymer chains are helicoidal with their axes parallel to c . (auth)

24004 KINETICS OF THE SOLID STATE POLYMERIZATION OF N-VINYLL CARBAZOLE. Tudos, F.; Boros-Gyevi, E. (Central Research Inst. of Chemistry, Budapest). pp 557-72 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Expressions were obtained for the γ -induced polymerization rate both during the induction period when the polymer of *N*-vinylcarbazole forms at a slow constant rate and during the second period when autocatalysis is the dominating process. The kinetics of the degree of polymerization are discussed in detail as is the mechanism of polymerization. (B.L.M.)

45160 POLYMERIZATION IN THE SOLID STATE AT HIGH PRESSURE. 3. INFLUENCE OF HIGH PRESSURE ON THE RADIOCHEMICAL POLYMERIZATION OF DIKETENE. Suzuki, T.; Tabata, Y.; Oshima, K. (Tokyo Univ.). *Makromol. Chem.*, 104: 236-43(1967). (In German).

Effects of pressure on radioinduced ring-opening polymerization of diketene in the solid state were investigated at 1 and 5000 kg/cm². Three series of tests were carried out, at -13, -78, and -196°C at a dose rate of 1.3×10^4 R/hr with ⁶⁰Co γ radiation. The monomeric diketene was submitted to pressure applied both before and during radioinduced polymerization. Polymerization reactivity was substantially elevated by applying high pressure while the reactivity under normal pressure was decreased by pretreatment under high pressure. Furthermore, it was confirmed that vinyl polymerization can proceed also in the solid state to some extent, and that this reaction is suppressed by high pressure. (BBB)

43005 RADIATION-INDUCED POSTPOLYMERIZATION OF TRIOXANE IN SOLID STATE. Sakamoto, M.; Ishigaki, I.; Kumakura, M.; Yamashina, H.; Iwai, T.; Ito, A.; Hayashi, K. (Japan Atomic Energy Research Inst., Takasaki). *J. Macromol. Chem.*, 1: 639-55(Oct. 1966).

A kinetic study of the radioinduced postpolymerization of trioxane in the solid state was made. The yield and the degree of polymerization of the polymer were estimated as a function of the preirradiation dosage and postpolymerization temperature. The yield-polymerization-time curves can be represented by an exponential equation. The degree of polymerization increases with the conversion. This means that the rate constant of the formation of active species is much larger than that of the termination reaction (k_t); $\tau = 1/k_t$ represents the average lifetime of the active species; the lifetime of the active species in the postpolymerization was calculated to be 10^4 to 10^5 sec. This value was found to be much larger than for the in-source polymerization. (auth)

36038 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF VINYL COMPOUNDS IN BINARY SYSTEMS. Nishii, Masanobu; Tsukamoto; Hiroshi; Hayashi, Koichi; Okamura, Seizo (Japanese Association for Radiation Research on Polymers, Osaka). *J. Appl. Polymer Sci.*, 11: 1117-28(July 1967).

The radioinduced solid-state polymerization in the binary systems such as acrylamide-methacrylamide and acrylamide-acenaphthylene was studied. The former system formed a solid solution, and the latter one formed a eutectic mixture. In the solid solution, the polymerization proceeds homogeneously and copolymer is formed, while in the eutectic mixture, it proceeds heterogeneously, forming only homopolymer. The post-polymerization of the same binary systems was also studied. Linearity between the conversion and the logarithm of the post-polymerization time was found for the various monomer compositions at various temperatures. This relationship satisfied the kinetic equation presented by Morawetz et al., for the post-polymerization of acrylamide. The kinetics of the binary systems might be considered similarly to the single system, considering that the crystalline state of the system is changed by the monomer compositions. (auth)

28004 RADIATION POLYMERIZATION OF CRYSTALLINE TRITHIANE. Carazzolo, G.; Mammi, M.; Valle, G. (Centro Ricerche Resine, Castellanza, Italy). *Makromol. Chem.*, 100: 295-6(1967).

By solid-state radioinduced polymerization of trithiane (orthorhombic, with $a = 7.668$, $b = 7.003$, $c = 5.285$ Å), twinned crystals of hexagonal polythiomethylene (PTM) ($a = 5.07$, $c = 36.52$ Å) were obtained. It was demonstrated that the solid-state polymerization takes place along the 2 diagonals of the trithiane a,b plane, which are 84°48' and 95°12' apart, thus giving rise to PTM twinned crystals having their c axes parallel to the trithiane [110] and [110] directions. Some new weak reflections, observed on long exposure photographs, which may not be compatible with this polymerization model are examined. All the new spots were explained by 2 small twinned crystals, having their c axes parallel to the c trithiane (rotation) axis and their a axes parallel to the trithiane [110] or [110] axes. Hence, it was concluded that the radioinduced solid-state polymerization of trithiane occurs mainly along the 2 diagonals of the trithiane a,b plane and, in a small amount, in the direction of the trithiane c axis. (BBB)

24011 RADIATION INDUCED SOLID STATE POLYMERIZATION OF ACENAPHTHYLENE. Zurakowska-Orszagh, J.; Gumulka, A. (Univ. of Warsaw). pp 633-42 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The γ-induced polymerization of acenaphthylene was studied in both the solid state and in methanol solutions. The solid-state polymerization was studied in air and in nitrogen by infrared spectroscopy. The conversion curves for crystalline and shock-cooled samples irradiated in both air and nitrogen were studied, and marked differences were noted in the two samples with a steady increase of the polymerization rate with increasing poly-acenaphthylene content noted in the shock-cooled system. The effects of addition of water and of temperature on the polymerization rate was also investigated. (B.L.M.)

45166 THE ROLE OF VARIOUS INORGANIC SOLID ADDITIVES IN RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF 3,3-BIS-CHLOROMETHYLOXETANE. Kagiya, Tsutomu; Izu, Masatsugu; Fukui, Kenichi (Kyoto Univ.). *Makromol. Chem.*, 102: 39-46(1967).

The effects of a large variety of solid additives on the γ radio-induced polymerization of 3,3-bis(chloromethyl)oxetane were studied. Some of the additives that accelerated the polymerization rate of the unpurified monomer showed no effect with the purified monomer. The results obtained with the pure monomer showed that the number of polymer chains under the same conditions was independent of the kind of solid additive, and was constant; and the rate of polymerization and the intrinsic viscosity of the polymer increased with irradiation dose. It was concluded that the additive acted by depressing a termination reaction by trapping the poison for polymerization. It was apparent that all the catalytic additives were strongly basic. Since the basicity corresponds to low ionization potential, the catalytic additives had marked ability to form a cation upon γ irradiation. Accordingly, it was considered that the total concentration of cation in the polymerizing system was larger in the presence of the catalytic additive than in its absence. (BBB)

45177 A NEW KIND OF ASYMMETRIC SYNTHESIS. THE RADIATION POLYMERIZATION OF TRANS-1,3-PENTADIENE INCLUDED IN OPTICALLY ACTIVE PERHYDROTIRPHENYLENE. Farina, Mario; Audisto, Guido; Natta, Giulio (CNR, Milan). *J. Amer. Chem. Soc.*, 89: 5071(Sept. 13, 1967).

An isotactic polymer in the solid state, trans-1,4-polypentadiene, was synthesized by γ-irradiation of PHTP (trans, anti, trans, anti, transperhydropentatriphenylene) inclusion compounds with trans-1,3-pentadiene. The polymer showed an unambiguous optical activity of sign opposite to that of PHTP: $[\alpha]_D^{25} + 2.5 \pm 0.3$ (CHCl₃) (Perkin-Elmer 141 polarimeter). At shorter wavelengths the rotary power increased considerably $[\alpha]_D^{365} + 6.4^\circ$, $[\alpha]_D^{365} + 9.8^\circ$. Present investigations are underway to determine whether polymerization starts from asymmetric radicals or ions obtained by irradiation of PHTP, or if it exclusively involves the guest molecules. (D.H.M.)

21990 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. XX. THE CHARACTERISTICS OF SOLID STATE POLYMERIZATION OF N-VINYLSUCCINIMIDE. Hardy, Gyula; Varga, Jozsef; Nagy, Gabor; Cser, Ferenc; Eroe, Janosne. *Magyar Kem. Foly.*, 73: 55-9(Feb. 1967). (In Hungarian).

32201 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XX. CHARACTERISTICS OF THE γ-RAY INITIATED SOLID STATE POLYMERIZATION OF N-VINYLSUCCINIMIDE. Hardy, Gy.; Varga, J.; Nagy, G.; Cser, F.; Eroe, J. (Polytechnical Univ., Budapest. Central Research Inst. for Physics, Budapest). *Acta Chim. Acad. Sci. Hung.*, 52: 305-18(1967).

The solid-state polymerization of N-vinylsuccinimide gives an amorphous polymer whose physical and chemical structure is identical with that of the product obtainable by polymerization in the liquid phase. The properties of the polymer, examinations by ESR spectroscopy, as well as earlier kinetic investigations, showed that N-vinylsuccinimide belongs to the class of monomers "non-polymerizing in the crystal lattice." A kinetic equation was derived to account for the accelerating character of the polymerization kinetic curves of this type of monomers. This equation takes into consideration the accumulation of free radicals and the influence of the amorphous polymeric phase produced during the reaction. (auth)

24006 KINETICS OF RADIATION INDUCED SOLID STATE POLYMERIZATION OF N-SUBSTITUTED ACRYLAMIDES. Orszagh, A.; Zurakowska-Orszagh, J. (Univ. of Warsaw). pp 593-92 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

A series of monomers ranging from acrylamide to N-tert-nonylacrylamide with comparatively large substituents and having the

are various alkyl groups, were irradiated with ⁶⁰Co γ radiation to study the effect of gradual structural change of the monomers on their ability to polymerize in the solid state. Remarkable differences were noted in the polymerization rates of the different monomers. From the kinetics of the radioinduced solid-state polymerization, a general curve was obtained that would fit the kinetics of any of the monomers. That this remarkable similarity in polymerization mechanism is due to quantitative rather than qualitative differences between the monomers is offered as an explanation for the one expression describing the kinetic curves of the series of monomers. (B.L.M.)

36037 RADIATION-INDUCED SOLID-STATE POLYMERIZATION IN BINARY SYSTEMS. V. POLYMERIZATION IN BINARY SYSTEMS CONTAINING LONG CHAIN COMPOUNDS. Kaetsu, Isao; Hayashi, Koichi; Okamura, Seizo (Kyoto Univ.). J. Appl. Polymer Sci., 11: 1101-16 (July 1967).

Radioinduced solid-state polymerization in binary systems containing long-chain compounds was investigated. Butyl stearate-methyl methacrylate and stearyl alcohol-methyl methacrylate systems were studied in detail. In these systems in-source polymerization did not occur but a remarkable post-polymerization took place on warming after irradiation at low temperature. The limiting conversion characteristics of this post-polymerization depended greatly on the nature and the concentration of the long-chain compounds. The post-polymerization was observed to be more marked in the butyl stearate-methyl methacrylate system than in the stearyl alcohol-methyl methacrylate system, and it increased with increasing concentration of the long-chain component. An optimum warming rate and warming temperature existed for the maximum saturated conversion. Irradiation in air caused some decrease of conversion compared to irradiation in vacuo. The possible mechanism is that monomer diffuses into the crystals of the long-chain compound after melting at the eutectic temperature. The polymerization may be initiated by trapped radicals of the long-chain compound and carried out in the crystal of the long-chain compound with a smaller possibility of termination. In binary systems containing long-chain compounds, lowering of the melting point was slight, and the eutectic composition existed at the richer composition of monomer, so almost all the long-chain substance remained as excess crystals, which were suitable for holding trapped radicals. The crystal lattices of long-chain compounds may be softer than those of compounds of small molecular size. This fact is favorable for monomer diffusion. This explains why such a post-polymerization takes place only in systems containing long-chain molecules. (auth)

25879 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. XVIII. MONOALLYL NORBORNENEDICARBOXYLATE AND SOME OF ITS BINARY SYSTEMS. Hardy, Gy.; Nyitrai, K. (Research Inst. for Plastics, Budapest). Acta Chim. Acad. Sci. Hung., 52: 105-13 (1967).

The solid-state polymerization of monoallyl norbornenedicarboxylate was investigated. The polymerization takes place by reaction of the allyl groups up to 20% conversion; at higher conversions an insoluble polymer is formed owing to participation of double bonds in the cycle of the monomer. The binary system consisting of monoallyl and monopropyl norbornenedicarboxylate gives an isomorphous solid solution. The propyl ester acts as physical barrier in the solid-state polymerization of the allyl ester; an increase of the concentration of the propyl ester results in a monotonous decrease of the rate of polymerization. The binary systems consisting of monoallyl ester and acetanilide, succinimide, and naphthalene, respectively, are characterized by the formation of eutectic mixtures. The characteristics of the solid-state polymerization of these binary systems indicate the formation of quasi-eutectic structures, namely the physical structures of the solid systems depend to a large extent on conditions of the cooling and crystallization processes. (auth)

24032 SOLID STATE POLYMERIZATION IN TWO-COMPONENT SYSTEMS. Hardy, Gy.; Varga, J.; Nagy, G.; Nyitrai, K.; Varga, E. (Technical Univ., Budapest. Research Inst. for Plastics, Budapest). pp 539-46 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Gamma-induced solid-state polymerization of the following systems was investigated: benzoquinone (BQ)-acrylamide (AA); BQ-trioxane (TO); BQ-vinyl laurate (VL); succinimide (SI)-TO; naphthalene (N)-TO. Previous reported work on these systems or on the solid-state polymerization of the monomer is reviewed and phase diagrams for the systems are presented. The polymerization kinetics of the systems were investigated in a wide range of compositions. Certain inhibitor studies were carried out, and it was concluded from the data that the mechanism of solid-state polymerization can only be determined for systems in which the destruction of the crystal lattice is favorable to polymerization. Strong retarding effects of inhibitors were noted in the polymerization of vinyl monomers with long aliphatic chains, and this indicated that the polymerization probably has a radical mechanism. (B.L.M.)

21989 KINETICS OF THE SOLID-STATE POLYMERIZATION OF N-VINYLCARBAZOLE. Tuedos, Ferenz; Boros-Gyevi, Edit (Central Inst. of Chemical Research, Budapest). Magyar Kem. Foly., 73: 60-8 (Feb. 1967). (In Hungarian).

The polymerization of N-vinylcarbazole, initiated by γ radiation, was examined. The process was found to be autocatalytic whose rate may be described by the expression $dx/dt = K_1 x^{1/2} (1-x)^2$ where $x = \xi/\xi_\infty$, and ξ is the conversion. The degree of polymerization changes according to a maximum curve and depends on the conversion as represented by the following equation: $\bar{P}(x) = P_0 x^\beta (1-x)$ where $\beta = 0.2 \pm 0.1$. Thus the expression for the rate of initiation is: $W_i = (K_1/P_0)(x(1-x))$. The elementary processes of the polymerization are discussed in detail. Initiation and chain growth take place at the interface between the polymer and monomer, while the chain termination process is probably to be interpreted by the "burial" mechanism. According to experiments made with chemical initiation, the kinetics of polymerization and the change of the degree of polymerization agree in the main lines with those found for radioinduced initiation. From this result it may be concluded that N-vinylcarbazole polymerizes by a radical mechanism in the solid state. (auth)

25894 RADIATION POLYMERIZATION IN THE SOLID PHASE. Komurka, Milos (National Commission for Tech., Prague). Chem. Listy, 61: 41-57 (1967). (In Czech).

Radiation polymerization in the solid phase is reviewed and several previously proposed mechanisms of radiation polymerization are discussed. Previously published results of radiation polymerization of a number of organic compounds are summarized. These compounds are classified into five groups based on relationship of the kinetics of the polymerization below and above the melting point of the monomer. Each of the five groups is characterized

by a diagram of reaction velocity versus temperature as well as a brief description of the behavior. The mechanism and kinetics of radiation polymerization in the solid phase are considered to be poorly understood, and research in the role of crystal structure in radiation polymerization is said to be needed. (TTT)

24005 RADIATION INDUCED POLYMERIZATION OF N-VINYL PYRROLIDONE IN THE SOLID STATE. Munari, S.; Tealdo, G.; Vigo, F.; Bonta, G. (Univ., Genoa). pp 573-81 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The gamma-induced polymerization of N-vinylpyrrolidone was studied in both the solid and liquid state. The rate of polymerization in the solid state increased after several hours to a value comparable with the values in the liquid phase. The rate was found to be dependent on temperature, but polymerization in neither phase was a simple function of dose rate. The initially low polymerization rate in the solid state followed by a rapid acceleration after some time was due to the following factors: crystalline structure of the monomer, increase of the sample temperature during irradiation, the role of the preformed polymer, and volume contraction during polymerization. (B.L.M.)

Chemicals Manufacture

23917 PRODUCTION OF CHEMICALS BY IONIZING RADIATION. Hall, G. R.; Clay, P. G. (Imperial Coll. of Science and Tech., London). Chem. Eng. (London), No. 204, CE336-43 (Dec. 1966).

The action of ionizing radiation on matter is briefly reviewed to clarify differences between reactions brought about by radiation and other forms of energy. The essential features of isotopic sources, electric machines producing electron beams, and chemical reactors are considered; and their application to chemicals production is discussed. Uses in polymer cross-linking, copolymerization, sulfonation, and production of ethyl bromide and polyethylene are examined. The facility offered by the irradiation process for tailoring the polymer and the possibility of producing ethylene copolymers (e.g., with carbon monoxide) has stimulated industrial interest. (BBB)

40933 METHOD FOR MAKING ALCOHOLS BY IONIZING RADIATION. (to Mobil Oil Corp.). British Patent 1,076,802. July 26, 1967. Priority date Oct. 2, 1963, United States.

A process for producing alcohols comprises irradiating with high-energy ionizing radiation a flowing mixture of reactants in the liquid or vapor phase. The reactant mixture consists of a starting alcohol having fewer C atoms than the product alcohol and an olefin. The dose rate is 1 to 40 MRAD/hr and the radiation is applied to the reactants for a period of time from 10 sec to 10 min. If the reactants are in the vapor phase, the temperature must be maintained sufficiently high to ensure complete vaporization. (B.L.M.)

40923 PREPARATION OF PERMSELECTIVE MEMBRANES BY MEANS OF A RADIOINDUCED GRAFTING. I. CATION-SELECTIVE. Munari, S.; Vigo, F.; Tealdo, G.; Rossi, C. (Univ., Genoa. Centro Nazionale Chimica Macromolecole, Genoa). *J. Appl. Polym. Sci.*, 11: 1563-70 (Aug. 1967).

Permselective cationic membranes were prepared by a radio-induced grafting method of styrene onto PTFE, and a preirradiation technique was used. Some attempts were made to characterize the membranes. They show mechanical properties similar to the PTFE matrix, and good electrochemical behavior, i.e., good permselectivity, which, nevertheless, decreased with decreasing solution concentration. Such behavior was related to a larger swelling in diluted solutions. Swelling properties in aqueous solutions of KCl and some organic solvents are also reported. (auth)

40913 RADIATION SYNTHESIS OF ION-EXCHANGE MATERIALS. Egorov, E. V. *Usp. Khim.*, 36: 1270-86 (July 1967). (In Russian).

Radiation synthesis of copolymers can be carried out by: direct grafting of a monomer on a polymer by irradiation; irradiating a polymer in vacuum with subsequent contact with a monomer; irradiating a polymer in air while heating in a monomer medium; cross-linking two irradiated polymers in the solid state, in a melt or in a solution; irradiating an emulsion of two polymers, or a polymer and a monomer; and grafting with localized neutron irradiation. Details of these methods of synthesis, analysis, and testing are reviewed. Integral doses from 0.1 to 10×10^6 rads are required at dose rates of 4 to 100 rads/sec. The homogeneity and strength of the copolymers are important properties. Ion-exchange resins and fibers can also be synthesized by radiation synthesis. (132 references). (TTT)

Oxidation

24026 MECHANISM OF THE RADIATION OXIDATION OF POLY(VINYL CHLORIDE). Zeppenfeld, G.; Wuckel, L. (Institut fuer Metallphysik und Reinstmetalle, Dresden). pp 765-74 of *Proceedings of the Second Tihany Symposium on Radiation Chemistry*. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

In an effort to explain the aging of poly(vinyl chloride) (PVC) under the influence of sunlight and air, the γ -induced oxidation of PVC in the presence of O_2 was investigated. The formation of hydroperoxide radicals, ROOH, and of peroxy radicals, ROO, were studied as a function of radiation dose and irradiation temperature. The hydroperoxide yield, dehydrochlorination, and chain scission were all found to be independent of dose rate and to require no thermal activation. It was assumed that chain fracture results from direct scission of C-C bonds under the influence of O_2 . G values are given for HCl formation and for chain fracture. (B.L.M.)

30478 RADIATION-INDUCED OXIDATION OF LIQUID METHANOL. Habersbergerova, A.; Janovsky, I.; Teply, J. (Inst. of Nuclear Research, Prague). *Collect. Czech. Chem. Commun.*, 32: 1860-70 (May 1967).

Determination of the dependence of the yields of hydrogen peroxide, hydroxymethyl hydroperoxide, and formic acid on oxygen concentration proved that oxygen is an efficient scavenger of CH_2OH radicals. Comparison of the experimentally found oxygen consumption with that calculated from the yields of oxidation products showed that the main products of the radioinduced oxidation of methanol were the previously mentioned products and formaldehyde. A reaction scheme is suggested, illustrating the dependence of the yields of hydroxymethyl hydroperoxide, hydrogen peroxide, formaldehyde, and oxygen consumption on the reciprocal square root of the dose rate and the independence of hydrogen yield of dose rate. At higher doses carbon dioxide was formed and formic acid was decomposed as a result of secondary reactions. (auth)

23987 RADIATION INDUCED OXIDATION OF CERTAIN PETROLEUM FRACTIONS INITIATED BY WATER EMULSION OF THEIR RADIOLYSIS PRODUCTS. Minc, S.; Bryl-Sandelevska, T.; Nowak, Z.; Wincel, H.; Stachowicz, W.; Kecki, Z. (Inst. of Nuclear Research, Warsaw). pp 409-16 of *Proceedings of the Second Tihany Symposium on Radiation Chemistry*. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The radiation yields of peroxides in emulsions and nonemulsion systems of a given petroleum fraction boiling between 290 and 320°C and containing 43% aliphatic hydrocarbons, 55% naphthalenic hydrocarbons, and 2% aromatic hydrocarbons are compared. The yield of oxidation products (peroxides, acids, and carbonyl compounds) produced by the addition of the products from γ radiolysis of the fraction and its water fraction are presented. The peroxide yields of the water emulsion were several times higher than the yields in the anhydrous system, and the yield increased with increasing absorbed radiation dose and temperature of irradiation. (B.L.M.)

23981 RADIOLYTIC OXIDATION OF METHANE. Hummel, R. W.; Hearne, J. A. (Atomic Energy Research Establishment, Wantage, Eng.). pp 353-64 of *Proceedings of the Second Tihany Symposium on Radiation Chemistry*. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Mixtures of CH_4 containing 10 vol % O_2 were γ -irradiated in a study to determine the initial G values of the products formed. Initial G values of 13 oxygenated and 4 hydrocarbon products are tabulated. The major oxygenated products are CH_3OOH , CH_2O , CH_3OH , and C_2H_5OH , and C_2H_4 is the main hydrocarbon product. This discussion of the experimental results is based on the idea that radiolysis leads mainly to the formation of CH_3 , H, and O, all of which react preferentially with O_2 to give CH_3O_2 , HO_2 , and O_3 . Subsequent reactions of the last mentioned species give rise to the products identified. Suggested reactions for the formation of the intermediate species and the final products are presented. (B.L.M.)

23986 RADIATION INDUCED CHAIN OXIDATION OF BENZENE TO PHENOL IN AQUEOUS SOLUTIONS OF FERROUS IONS AND OXYGEN. Kartasheva, L. I.; Pikaev, A. K. (Inst. of Physical Chemistry, Academy of Sciences, USSR). pp 399-408 of *Proceedings of the Second Tihany Symposium on Radiation Chemistry*. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

High radiolytic yields of Fe^{3+} , C_6H_5OH , and $C_6H_5O_2$ were measured after γ and electron irradiation of aerated sulfuric acid solutions of benzene containing Fe^{2+} ions, and the high yields were interpreted as positive evidence of a chain process in the system. Suggested mechanisms for the chain process are presented, and a detailed kinetic analysis of the possible reactions is shown. (B.L.M.)

Chlorination

45161 RADIATION CHLORINATION OF KEROSENE. Dzhatgatspanyan, R. V.; Lyaskin, Yu. G.; Filippov, M. T.; Sinitin, V. I.; Yakimenko, L. M.; Glebova, L. I.; Zetkin, V. I. *Khim. Prom.*, No. 5, 338-40 (May 1966). (In Russian).

Data were obtained for the chlorination of paraffinic hydrocarbon mixtures in the presence of γ radiation from a ^{60}Co source. Results are given for temperatures between 20 and 60°C and dose rates between 0.81 and 26.1 RAD/sec; at the maximum rate and temperature, 60% conversion was obtained in 30 min. A linear correlation was obtained between log G and dose rate at 20° for several different stages of chlorination. Log K, where K is the pre-exponential term for G, is a linear function of the Cl content of the mixture. Results are compared with those of chlorinations induced photochemically and by azobisisobutyronitrile. Results indicate that desired products are obtained much more quickly by radiation chlorination than by the other routes. (BBB)

38964 EFFECT OF GAMMA IRRADIATION ON SOLID-STATE CHLORINATION OF POLYETHYLENE. Dzhatgatspanyan, R. V.; Korolev, B. M.; Romanski, I. A.; Zetkin, V. I. *Vysokomol. Soedin.*, Ser. A, 9: 1195-1200 (June 1967). (In Russian).

Chlorination of low-pressure polyethylene in the solid state caused by ^{60}Co γ -irradiation was carried out. Kinetic treatment of the reaction was attempted in the amorphous phase of the polymer. (auth)

23982 RADIATION CHLORINATION OF CHLOROPENTANES. Lebedev, D. D.; Vereshchinski, I. V. (Karpov Inst. of Physical Chemistry, Moscow). pp 365-9 of *Proceedings of the Second Tihany Symposium on Radiation Chemistry*. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The effects of temperature and dose rate on the γ -induced chlorination of 1,1,1,5-tetrachloropentane were investigated. A chain reaction mechanism is suggested to explain the formation of the identified products, penta-, hexa-, hepta-, octa-, nona-, and decachloropentanes. Rate constants were calculated for some chloropentanes at different temperatures, and the dependence of the radiation chemical yield of polychloropentanes on the dose rate was calculated and tabulated. (B.L.M.)

Addition

23943 THE ADDITION REACTIONS OF ETHANOL TO ETHYLENE INDUCED BY GAMMA-RAY IRRADIATION IN THE GASEOUS PHASE. I. RESULTS AND THE REACTION MECHANISMS. Hotta, Hiroshi; Kurihara, Hirono; Abe, Toshihiko (Japan Atomic Energy Research Inst., Takasaki). Bull. Chem. Soc. Jap., 40: 714-18 (Apr. 1967).

In the reactions studied, the major products in the gaseous phase were 2-alkanols, 3-methyl-3-alkanols, and 2-ketones, while low hydrocarbons were found only at temperatures higher than about 150°C. The reactions in the liquid phase, carried out at 100°C, did not give 2-ketones. The major primary precursor was the 1-hydroxyethyl radical. The radicals produced by its addition to ethylene, $\text{CH}_3\text{-CH}(\text{OH})\text{-(CH}_2\text{)}_n$, gave not only 2-alkanols but also radicals, $\text{CH}_3\text{-C}(\text{OH})\text{-(CH}_2\text{)}_{n-1}\text{-CH}_3$, as a result of rearrangement by the intramolecular hydrogen transfer. Some of the latter radicals acted as precursors of 3-methyl-3-alkanols by their addition to ethylene, while the rest of the radicals gave 2-ketones by hydrogen abstraction by ethylene. The latter reaction gave the ethyl radical, which was the precursor of various hydrocarbons. The intramolecular hydrogen transfer occurred even in the liquid phase to give 3-methyl-3-alkanols, but the rearranged radicals gave 2-ketones only in the gaseous phase. (auth)

23944 THE ADDITION REACTIONS OF ETHANOL TO ETHYLENE INDUCED BY GAMMA-RAY IRRADIATION IN THE GASEOUS PHASE. II. A KINETIC ANALYSIS OF THE RESULTS. Kurihara, Hirono; Hotta, Hiroshi (Japan Atomic Energy Research Inst., Takasaki). Bull. Chem. Soc. Jap., 40: 719-23 (Apr. 1967).

In order to analyze the results obtained in Part I (H. Hotta and H. Kurihara, Bull. Chem. Soc. Japan, 40: 714 (1967)), a general kinetic expression for the system which involves side chain reactions was derived by a modification of the Gale and Wagner method (J. Am. Chem. Soc., 86: 4531 (1964)) on the basis of the G-values without the steady-state approximation. By the use of this expression, the chain transfer constants were found to be $C_1' = 0.093$ and $G_1' = 0.074$ in the gaseous phase, and about $C_1' = 0.007$ in the liquid phase. These values were compared with the reported chain transfer constants for related systems. (auth)

30457 RADIATION-INDUCED ADDITION REACTION OF THIOLS TO CHLOROFLUOROETHYLENES. Ueda, Teruo; Inukai, Kan (Government Chemical Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 16: No. 2, 42-7 (Feb. 1967). (In Japanese).

The addition of thiols to chlorofluoroethylenes was carried out under γ irradiation to produce chlorofluoroethyl alkyl sulfides. Chlorofluoroethyl alkyl sulfoxides and sulfones were prepared by oxidation of the sulfides. The dehydrohalogenation of chlorofluoroethyl alkyl sulfides yielded chlorofluorovinyl alkyl sulfides, whose structure indicated that the thiyl radical attacks the difluoromethylene side of the asymmetrical dichlorodifluoroethylene. Chlorofluorovinyl sulfoxides and sulfones were also synthesized from the sulfides by oxidation with hydrogen peroxide. (NSA of Japan)

23942 RADIATION-INDUCED ADDITION REACTIONS OF ETHERS AND ALCOHOLS TO PERFLUOROPROPENE. Muramatsu, Hiroshige; Inukai, Kan; Ueda, Teruo (Government Inst. Research Inst., Nagoya, Japan). Bull. Chem. Soc. Jap., 40: 903-7 (Apr. 1967).

The radioinduced addition reactions of ethers and alcohols to perfluoropropene were studied. The 1:1 adducts were obtained in excellent yields, but in the addition of diethyl ether and dioxane the 1:2 adduct with a symmetrical structure was produced along with the 1:1 adduct. The others containing the perfluoropropenyl group were prepared by the dehydrofluorination of the corresponding 1:1 adduct. From the proton and fluorine NMR spectra, the attacks of the α -etheral and α -hydroxyalkyl radicals were found to occur exclusively on the difluoromethylene carbon. The relative reactivities of ethers and alcohols were determined by competitive reaction. (auth)

21993 RADIATION INITIATED ADDITION REACTIONS. VI. ADDITION OF BENZENETHIOL ON OLEFINS. Rabilloud, Guy (CEN, Grenoble, France). Bull. Soc. Chim. France, No. 2, 384-7 (Feb. 1967). (In French).

The radiochemical initiation of the addition of benzenethiol on the double bond of aliphatic and alicyclic olefins is a way of synthesizing arylaliphatic sulfides. The reactions proceed by a radical chain mechanism leading to an "abnormal" addition product in high yield, but with olefins having an internal double bond, there is a formation of two isomeric sulfides depending whether the phenylthiyl radical fixes on either one or the other unsaturated carbon atoms. The efficiency of γ rays as initiating agent calculated on the basis of the total radiochemical yield varies between 50 and 100. (auth)

Carboxylation

36050 ON THE FORMATION OF AMINO ACIDS BY GAMMA-RAY-INDUCED CARBOXYLATION OF AMINES IN AQUEOUS SOLUTION. Getoff, N.; Schenck, G. O. (Max-Planck-Institut fuer Kohlenforschung, Ger.). Radiat. Res., 31: 486-505 (July 1967).

The γ -induced formation of amino acids was studied by means of carboxylation of amines in aqueous solutions with ethylamine, n-propylamine, isoamylamine, and pyrrolidine as model substrates. The carboxylation process was investigated as a function of radiation dose, pH value of the solution, concentration of amines, and carbon dioxide. As a rule, by the carboxylation of the individual amines several amino acids were formed. This suggests that, under the influence of radiation, various free amino radicals are produced from the corresponding amine. In dilute solutions of amine ($<10^{-1}$ mole/liter) the primary products of water radiolysis ($\text{OH}^\cdot$, $\text{H}^\cdot$, e_{aq}^-) play a dominant role. In this case an H atom is abstracted preferentially from the α -C atom of the amine. Simultaneously with these processes CO_2 is reduced by e_{aq}^- and H atoms to $\text{COO}^\cdot$ radical ions and COOH radicals. The free amino radicals are subsequently carboxylated, yielding the corresponding α -amino acids with G_1 up to 1.25. Dehydrogenation at other positions in the amine molecule occurs only to a minor extent, generally, these secondary reactions resulting in alkylation and, in ethylamine carboxylation, even cyclization. This effect will become more pronounced with high doses as the carbon dioxide is used up in the reaction. At higher amine concentrations (above 10^{-1} mole/liter) direct radiation effects become more and more important. Free amino radicals and radical ions result from the splitting of amine molecules into different fragments. Under the experimental conditions not all amino radicals are carboxylated; therefore higher amines are obtained also. In the study of the carboxylation of amines as a function of radiation dose the yield of all amino acids tends to reach a limiting value; the amino acids formed will react with the primary products of water radiolysis above a certain concentration. The yield of amino acids increases with increasing carbon dioxide concentration in the solution. The amino acid yield from the carboxylation of different amines is strongly pH-dependent. In preliminary experiments amino acids were formed by amination of acetic and propionic acid, their yield being comparable to the yield obtained from the carboxylation of the corresponding amines. (auth)

Synthesis

23920 RADIOCHEMICAL SYNTHESIS OF DICHLORO- AND TRIALKYLPHOSPHINES. Babkina, E. I.; Vereshchinskii, I. V. Zh. Obshch. Khim., 37: 513 (Feb. 1967). (In Russian).

A method is suggested for radiochemical synthesis of dialkylchloro- and trialkylphosphines by γ -irradiation of a liquid mixture of alkylchlorophosphine (R_2PCl_2) and any hydrocarbon ($\text{R}'\text{H}$) producing 50 to 60% dialkylchlorophosphine ($\text{RR}'\text{PCl}$) and 10 to 15% trialkylphosphine ($\text{RR}'_2\text{P}$). A series of dialkylchlorophosphines were synthesized (R_2PCl_2), where $\text{R} = \text{C}_6\text{H}_{13}$, $\Delta\text{-C}_8\text{H}_{17}$, and C_8H_{17} . (R.V.J.)

Materials Modification

40904 BEHAVIOR OF COAL DURING IRRADIATION IN THE PRESENCE OF CHLORINE OR OXYGEN. Muller, J.-C.; Le Bouffant, L. Chim. Ind. (Paris), 97: 1315-20 (May 1967). (In French).

Coal was irradiated with ^{60}Co at dose rates of 50 KRAD/hr and 1.75 MRAD/hr. Formation of CO_2 and H_2O as a function of temperature was followed. Oxidation and chlorination tests were carried out with and without γ -irradiation of the samples. The effect of oxygen was examined by studying the kinetics of oxidation and by determining such characteristics of the coal as elementary composition, heating capacity, smoke-producing capacity, and pyridine-extract composition. During the chlorination tests the kinetics of fixation of chlorine was studied and the elementary composition of pyridine extracts was determined. It was concluded that under the conditions of the experiments (0 to 200°C with doses up to 4 MRAD for chlorination, or 50 to 260°C with doses up to 82 MRAD for oxidation) that γ -irradiation had no detectable effects on these processes. (BBB)

40931 STABILIZATION OF SULPHUR TRIOXIDE BY RADIATION. (to Tennessee Corp.). British Patent 1,078,835. Aug. 9, 1967. Priority date Sept. 17, 1964, United States.

A method for stabilizing SO_3 consists of irradiating the substantially anhydrous liquid SO_3 with ionizing radiation for a period of 30 min to 24 hr at a dose rate of 1.4×10^6 RAD/hr or greater. (B.L.M.)

41045 RADIATION EFFECTS ON FLOTATION OF MINERALS. Plaksin, I. N.; Mal'sheva, N. G.; Starchik, L. P. Dokl. Akad. Nauk SSSR, 175: 663-4 (July 21, 1967). (In Russian).

An improved pneumatic flotation chamber of Hillmond-Clasien construction was used in the investigation of beryllium, spodumene, ilmenite, hubernite, pyrochlore, and pyrate flotation in a radiation field with radiation source of ^{90}Sr and ^{90}Y of 500 mCi activity (the maximum β radiation $E_{\text{max}} = 2.27$ MeV) and $^{144}\text{Ce} + ^{144}\text{Pr}$ of ~ 3 Ci activity (maximum β radiation $E_{\text{max}} = 3.15$ MeV). Flotation with oleic acid as absorbent-reagent increased the froth product of spodumene 8%, ilmenite 9%, pyrochlore 15%, and reduced the froth yield of zirconium 5%, hubernite 3%, and rutile 5%. The duration of flotation was 30 to 40 min. Flotation directly in radioactive fields increased the yield and extraction of valuable components, increased selectivity of the reagents and reduced reagent consumption. (R.V.J.)

24021 MODIFICATION OF POLYESTER TYRE CORD AND FOIL TO INCREASE THEIR ADHESION TO RUBBER. Bulhak, Z.; Zielinski, W. (Inst. of Nuclear Research, Warsaw). pp 727-31 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Experiments were carried out to modify poly(ethylene terephthalate) tire cord and foil to increase their adhesion to rubber by radioinduced graft copolymerization of monomers onto the cord or foil. Gamma radiation was used to induce the grafting of the following monomers: styrene, butadiene, dimethyl butadiene, and methacrylic acid. All the monomers increased the adhesion of the foil to the rubber with the best adhesive properties being obtained with dimethyl butadiene. The most efficient monomer for improving the adhesive properties of the cord was styrene giving a 95% rise in adhesion to rubber. Butadiene and dimethyl butadiene were much less efficient as adhesion improvers but they did not change the elasticity of the yarns. (B.L.M.)

26931 EFFECT OF RADIATION ON ADHESION OF POLYMER COATINGS ON ALUMINUM. Kabanov, V. Ya.; Grozinskaya, Z. P.; Zubov, P. I.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 169: 146-9 (July 1, 1966). (In Russian).

A comparative study was made on adhesion of 500 to 600- μ thick epoxy, polyester, perchloroethylene, and polyurethane coatings on aluminum foil before and after irradiation at a low (from ^{60}Co source) or high ($\sim 10^4$ rad/sec from a linear accelerator) dose rate of ionizing radiation. A stripping method was used to evaluate adhesion. Energy of adhesion was also determined during irradiation with a high-intensity electron beam (from the linear accelerator). An increase in adhesion of all coatings studied was noted after prolonged irradiation at a low dose rate (163 rad/sec), in air or vacuum, together with an increase in rigidity and brittleness of all.

39708 THE WEAR PROPERTIES OF HIGH-DENSITY POLYETHYLENE IRRADIATED BY GAMMA RAYS. Matsubara, K.; Watanabe, M. (Government Mechanical Lab., Tokyo). Wear, 10: 214-22 (May-June 1967).

The wear properties of γ -irradiated polyethylene were compared with those of unirradiated samples. The specimens were irradiated using ^{60}Co at dose rates from 3.5×10^4 to 8.1×10^5 R/hr to a maximum dose of 2×10^6 R. The wear of specimens sliding on a steel specimen coated with Cr over a load range from 5 to 20 Kg/cm 2 is shown as weight loss per sliding distance of 1000 m. Loads from 5 to 10 Kg/cm 2 had little effect on the unirradiated samples; however, at a load of 12 Kg/cm 2 the whole sliding surface melted over a few millimeters. The relation between area and radiation dose was expressed linearly up to about 2×10^6 R, and when the dose exceeded this value, the wear became abnormally low. At a load of 10 Kg/cm 2 , the wear increased with increasing radiation dose. The variation of wear with radiation dose could be explained by the % of crosslinking, which increases with increasing radiation dose. The results of wear tests with an abrader were about the same as those without an abrader. (TSS)

26469 IMPROVEMENTS RELATING TO NOVEL TEXTILE PRODUCTS. (to Daido Keori Kabushiki Kaisha). British Patent 1,059,353. Feb. 22, 1967. Priority date Aug. 7, 1962, Japan.

A textile product is described that is designed to give protection from radioactivity, particularly radioactive fallout. The textile consists of a fibrous material impregnated with high-molecular-weight products formed by curing a synthetic resin in the presence of an organic amino carboxylic acid, or a Na, K, NH_4^+ , Al, Ba, or Ca salt of this acid and water: (B.L.M.)

24041 IMPROVEMENTS RELATING TO THE MANUFACTURE OF PLASTICS. Charlesby, Arthur; Pinner, Solomon Harris (to T. I. (Group Services) Ltd.). British Patent 866,069. Apr. 26, 1961. Filed Feb. 14, 1956.

A process for improving the properties of a polymer comprises mixing the polymer with a poly-functional monomer containing at least two potentially reactive C to C double bonds with one pair of C atoms joined by double bonds separated from the next pair of such C atoms by at least one C atom and crosslinking the polymer with the monomer by subjecting the mixture to the effects of electrons, gamma radiation, or x rays. The process may be carried out in the presence of a second monomer, which has the function of enhancing the compatibility of the polymer and the first monomer and which may or may not be polyfunctional. The process is applicable to the cross-linking of polymers of ethylene, methylmethacrylate, vinyl chloride, acrylonitrile, or cellulose acetate. The polyfunctional monomer may be divinyl benzene, ethylene dimethacrylate, or diallyl phthalate. The second monomer is chosen from vinylidene chloride or lauryl methacrylate. (B.L.M.)

38983 EFFECTS OF HIGH ENERGY IRRADIATION ON THE ELECTRIC PROPERTIES OF EPOXY RESINS. Boino, Horst (Research Station for High Energy Physics, Berlin). Wiss. Z. Elektrotech., 7: 233-45 (1966). (In German).

Specimens of cold-setting and thermosetting epoxy resins were irradiated by a 1.5-MeV electron beam with a 10^6 to 10^{10} RAD dose at a 10^5 RAD/sec dose rate. Distintegration of the specimens took place only at high temperatures during irradiation. Both resins showed brown coloring, which increased with dosage. Conductance, surface resistance, track resistance, flashover potential, specific inductive capacity, and phase-angle difference were measured after irradiation. Within 20 hr after irradiation a substantial recovery from radiation effects was observed. The epoxy resins proved to be able to sustain the reported radiation load. (JPRS)

25882 EFFECTS OF X RADIATION ON THE STRENGTH STABILITY OF POLYMETHYL METHACRYLATE. Tynnyl, A. N.; Mikitishin, S. I.; Velikovskii, A. A.; Khomitskii, Yu. N.; Kolevov, Yu. A. (Inst. of Physics and Mechanics, Lvov). Fiz.-Khim. Mekh. Mater., 3: No. 1, 42-5 (1967). (In Russian).

The effects of x-irradiation on the resistance properties of polymethyl methacrylate (PMMA) in air and water media were studied under tension and tension-free. A significant weakening of PMMA began with a dose as low as 7×10^4 Joule/kg. The strength of PMMA was greater when under simultaneous tension and irradiated force. Results also showed that x radiation inhibits PMMA stability in water. (R.V.J.)

24008 RADIATION INDUCED ELECTRICAL CONDUCTIVITY DURING SOLID STATE POLYMERIZATION. Hedvig, P. (Plastics Research Inst., Budapest). pp 599-606 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Current change during the course of radioinduced solid-state polymerization was investigated by two methods: dc current method and the pulse method. In the dc current method, a constant dc voltage is applied to the sample after gamma irradiation to compensate the dark current flowing across the sample. A certain correlation was observed between the induced currents and polymerization. However, two difficulties were noted in correlating the equilibrium currents to polymerization. First, the monomer is a poor heat conductor, and the actual temperature of the sample changes continuously during the course of the irradiation. Second, the induced currents are dependent on the change of physical structure of the material and on the concentration of the free radicals formed by the irradiation. In order to ensure adiabatic conditions for the charge carriers, x-ray pulses were used. An expression is given for the dose-rate dependence of the induced current pulses. The data indicate that trapping centers formed during the course of the polymerization reaction disappears on prolonged storage. The charge-carrier mobilities were found to be not much affected by structural changes during the polymerization process. (B.L.M.)

25927 ELECTRIC CABLES INSULATED WITH RADIATION CROSS-LINKED POLYVINYL CHLORIDE. White, Francis Thomas; Mann, Ronald (to Associated Electrical Industries Ltd.). British Patent 1,066,610. Apr. 26, 1967. Filed Mar. 25, 1965.

A process for improving the hardness of poly(vinyl chloride) in the temperature range from 100 to 160°C for use as electric cable insulation comprises coating an electrical conductor with a composition made up of vinyl chloride and a polyfunctional unsaturated ester and subjecting this to high-energy electron radiation to accomplish polymeric crosslinking. The radiation dose should be in the range of 0.5 to 20 Mrads. (B.L.M.)

20985 DEVELOPMENT OF POLY(VINYLCHLORIDE)-INSULATED ELECTRIC WIRES USING ELECTRON-BEAM IR-

RADIATION. Izumi, Masahiro; Suzuki, Fumio; Yuri, Tooru. *Sumitomo Elec. Tech. Rev.*, No. 9, 50-6 (Mar. 1967).

Choosing the proper irradiation conditions for improving the properties of PVC by irradiation is discussed. Several experimental results concerning the crosslinking effects by different irradiation such as atmosphere, radiation source, and PVC compositions (crosslinking agent, polymer, stabilizer, plasticizer, fillers, etc.) are discussed. From these results, electrical wires insulated with irradiated crosslinked PVC were produced and tested. Improved properties of the wires are as follows: heat resistance property; non-solvent property for chemical agents; and electric properties (e.g., insulation resistance is about ten times higher than ordinary). Irradiated crosslinked PVC shows many interesting properties and can also be applied for many other uses. (auth)

Sewage Treatment

43201 IMPROVEMENTS IN OR RELATING TO METHODS AND APPARATUS FOR TREATING SEWAGE. Mitchell, Keith James (to General Electric Co., Ltd.) British Patent 1,079,632. Aug. 16, 1967. Filed Mar. 30, 1965.

A method for treating raw sewage is described in which colloidal suspended materials are precipitated by ionizing radiation produced by gamma rays emanating from cooling fuel elements. (F.S.)

Vulcanization

24024 MECHANISM OF RADIATION VULCANIZATION OF LATEX. Todorov, I. M. (CEN, Saclay, France). pp 749-56 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

Studies were carried out to elucidate the mechanism of irradiation crosslinking of rubber in the latex phase. Natural rubber latex was irradiated at room temperature and at -180°C with a ^{60}Co source, and the influence of the radicals and free electrons was studied by the addition of selective interceptors. The interceptors investigated were n-propanol, isopropanol, KI_3 , nitroethane, nitrobenzene, CHCl_3 , CCl_4 , CH_2Cl_2 , $\text{CH}_2\text{ClCHCl}_2$, and $\text{C}_6\text{H}_4(\text{CH}=\text{CH}_2)_2$. All the Cl-containing products and divinylbenzene increased the degree of intermolecular crosslinking, while the nitroproducts and KI_3 delayed it. An essential difference was noted in the degree of crosslinking when the irradiation was performed at the two vastly different temperatures. (B.L.M.)

Wood Treatment

42966 (NP-tr-1565) WOOD-PLASTIC COMPOSITE, WPC. Miettinen, J. K. Translated from Kem. Teollisuus, 23: 1084-8 (1966). 8p. Dep. CFSTI. JCL \$1.10 fs, \$0.80 mf.

Studies were made of the production of wood-plastic combinations by impregnating wood blocks with monomers and irradiating them. Bending strength of the wood was increased, shearing strength increased, and water absorption decreased. Dimensional changes in the wood were greatly reduced. Uses of the wood-plastic combinations are discussed. (M.C.G.)

45305 (AD-640660) EVALUATION OF IRRADIATED WOOD-PLASTIC COMBINATIONS FOR USE AS GUN STOCKS. Jennings, E. A.; Eisler, S. L. (Army Weapons Command, Rock Island, Ill. Research and Engineering Div.). Sept. 1966. 16p. (RIA-66-2791). CFSTI.

Wood-plastic combinations were prepared from four wood species: white pine, yellow pine, maple, and walnut by impregnation with methyl methacrylate and subsequent exposure to gamma radiation. Results of static bending, hardness, and toughness tests showed no appreciable improvement in the properties beyond those of the untreated walnut. Furthermore, increased weight and cost indicate that wood-plastic materials prepared from readily available cost woods would not serve as suitable substitutes for walnut gun stocks. (auth) (TAB)

34307 MODIFICATION OF WOOD BY RADIATION. I. THE IMPROVED POPLAR-STYRENE SYSTEM. Varga, Stefan (Slovak Technical Univ., Bratislava); Kosik, Martin; Katuscak, Svetozar. *Jad. Energ.*, 13: 220-4 (June 1967). (In Czech).

Radiation chemistry affords possibilities in impregnating natural macromolecular substances with synthetic polymers. The combination of poplar wood with styrene by means of gamma radiation is described. Styrene impregnation methods are described. The problems of the distribution of styrene and polystyrene formed under radiation in poplar wood, as well as some physical, chemico-physical, and mechanical properties of the products were investigated. (auth)

34310 CURING OF DRYING OIL IN WOOD FIBER WEBS BY GAMMA-IRRADIATION. Pasner, Laszlo. Vancouver, Univ. of British Columbia, 1966.

Thesis.

A technique is described for improving wood fiber web strength by copolymerization of a hydrocarbon drying oil (CTLA Polymer) within handsheets made from pure and admixed forms of high yield chemical (sulfite and sulfate) and groundwood fibers. Oil polymerization can be initiated successfully by prolonged thermal treatment at 145°C , as well as by the method of low-dosage γ irradiation. The treatment strengthens interfiber bonding. Evidence for copolymerization was sought through assessment of tensile and related strength data on variously treated standard handsheets. Effectiveness of the polymerization on pulp types investigated as initiated by heat and low dosage irradiation is strongly related to surface colloidal and basic physical and mechanical properties of the fibers. Maximum strength parameters were obtained with oil-saturated sulfite and groundwood handsheets following polymerization by thermal treatment. Copolymerization efficiency by irradiation, on the other hand, is estimated as 73% for sulfite, 65% for groundwood, and 50% for kraft handsheets. Effectiveness of oil polymerization by irradiation was found to be proportional to dosages up to 10^6 RAD. Limit of strength improvement was not set entirely by intrinsic fiber strength, but was also influenced by surface colloidal properties of the fibers. Blends made from chemical-groundwood fiber mixtures behaved more or less proportional to individual pulp strengths and extent of blending. Copolymerized sulfite-groundwood blends at equal proportions approximated the tensile strength of similar kraft papers suggesting better economy with kraft fibers when papers of limited strength are produced. All other strength parameters (elastic modulus, tensile strain, and tensile energy absorption) followed similar trends, or if different were of aid in explaining certain phenomena characteristic of treated fiber webs. The presence of graft copolymer could not be conclusively proven, since both the copolymer and oil homopolymer are insoluble in the usual organic solvents. A dual character of the oil polymer was demonstrated with glass filter paper and highly purified commercial cellulose fibers. Effectiveness of oil polymerization in highly lignified mechanical pulps was greatly depressed by mild sodium chlorite treatment, although the strength and bonding capacity of such fibers increased considerably. This was taken as direct evidence for the possibility of a lignin-CTLA polymer copolymer system. Site of chemical reaction was not described, although means for assessment of such information are suggested. The study proves the usefulness of γ -irradiation as energy source for the copolymerization of drying oils in handsheets as replacement for the prolonged thermal treatment hitherto used by the hardboard industry. Added advantages of radiation-processed copolymerized papers are less discoloration, especially with high lignin content pulps, and lower elastic modulus, a factor clearly objectionable for some paper uses. (Disser. Abstr.)

38986 RADIATION-CHEMICAL EFFECTS IN THE WOOD-VINYL MONOMER SYSTEMS. Varga, S.; Kosik, M. (Slovak Technical Univ., Bratislava). *Atomtech. Tajek.*, 10: 391-406 (1967). (In Hungarian).

Radiation is used to facilitate the combination of wood with plastics, initiating in situ polymerization reactions in wood impregnated with monomers. The basic reaction involves homopolymerization. The radioinduced process, which takes place with formation of free radicals, has the advantage that the final product is free from contamination by foreign chemicals used for initiating the reaction. The length of the chains formed depends on the dose rate: high dose rates create shorter molecules. The monomer systems used include styrene, acrylic compounds, and vinyl monomers. Very high radiation, exceeding a total dose of 10^8 R, affects the wood; the lignin component is more resistant than the cellulose. Radiolysis of wood is related to the degradation of saccharides and the dissolution of the lignin-saccharide bonds. The monomer-impregnated specimens are usually irradiated with a $10^3\text{-Ci } ^{60}\text{Co}$ source; for very thin wood specimens, Van de Graaff accelerators may be used. Completion of the polymerization reaction is usually difficult to detect. (Review article, 116 references). (TTT)

24033 WOOD-PLASTIC COMBINATIONS PREPARED BY IRRADIATION WITH GAMMA RAYS AND HIGH ENERGY ELECTRONS. Singer, K. A. J. (Danish Atomic Energy Commission, Risoe, Denmark). pp 715-26 of Proceedings of the Second Tihany Symposium on Radiation Chemistry. Dobo, Janos; Hedvig, Peter (eds.). Budapest, Akademiai Kiado, 1967.

The electron- or γ -induced graft polymerization of three monomer systems, methyl methacrylate, vinyl acetate, and a styrene-acrylonitrile mixture in three different species of Scandinavian woods (spruce, pine, and beech) was investigated. The effects of dose rate, type of wood, irradiation temperature, and additives, such as CCl_4 and water, are all reported. Graft polymers were not formed during γ -irradiation of methyl methacrylate in dried wood, but when the wood was swollen with water before impregnation, a large proportion of graft copolymer was formed. The amount of "fixed" polymer was twice as high in spruce as in pine and beech for methyl methacrylate, and the molecular weight of the extractable polymer was much higher for spruce than for the other two woods. (B.L.M.)

Catalysis

38984 CATALYTIC CARBON MONOXIDE OXIDATION ON X-IRRADIATED ALUMINA. Coekelbergs, R.; Collins, R.; Crucq, A.; Decot, J.; Degols, L.; Timmerman, L. (Ecole Royale Militaire, Brussels). *J. Catal.*, 7: 85-95 (Jan. 1967).

The influence of ionizing irradiation of the catalytic properties of alumina was studied in a flow system for oxidation of CO over the temperature range from 25 to 400°C. The catalyst was submitted to irradiation with x rays (55 KV) at a dose rate of 2×10^{19} eV g⁻¹ hr⁻¹. Comparison of the results obtained under similar conditions with and without irradiation, indicated that, at a temperature below 300°C, the catalytic activity of irradiated alumina is much higher. This fact may be related to the marked lowering of activation energy with irradiated alumina (18 kcal for the unirradiated catalyst, about 0 kcal in the temperature range from 80 to 300°C, and about 4 kcal at lower temperature for the irradiated alumina). Nevertheless, the reaction order under irradiation remained the same as for unirradiated catalyst; it approached unity with respect to CO pressure, and was between one-fifth and one-half with respect to O₂ pressure. These results as well as previous ones related to the adsorption of CO, O₂, and CO₂ on alumina submitted to irradiation indicated that the rate-determining step for the catalytic oxidation of CO on Al₂O₃ is the chemisorption of O₂. This step is accelerated to a considerable extent by irradiation of alumina. (BBB)

24035 CHEMICAL ACTIVATION OF SOLID SURFACES BY RADIATION. Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Academy of Sciences, USSR). pp 5-11 of *Radiatsionnaya Fizika*. IV. Ionnyc Kristally. Shvarts, K. K. (ed.). Riga, Izdatel'stvo Zinatne, 1966. (In Russian).

The effect of radiation on matter is reviewed. These radiation effects depend on the following factors: continuous excitation of electrons in the irradiated atoms; the appearance of local charge on the sample surface due to the emission of charged particles and liberated electrons; defect formation in the crystal lattice due to recoil; or to the interaction of radiation with the atoms. The rate of isotopic sulfur exchange at a temperature of 1113°K in the heterogeneous K₂S*O₄-SO₃ system passes through a maximum and a minimum on increasing the specific activity from 2 to 35 mCi/g. Apparently an unstable pyrosulfate is formed by the reaction: K₂SO₄ + SO₃ = K₂S₂O₇. External irradiation of K₂SO₄ in SO₃ vapor with high-energy electrons has no effect on the rate of isotopic exchange. The evaporation rate of MoO₃ showed a minimum, which disappeared when a grounded Pt wire was introduced into the crucible. The dehydration of cyclohexanol over MgS*O₄ showed analogous effects. (TTT)

23912 CONVERSION OF N-HEXANE OVER ALUMINA-CHROMIA-POTASSIA CATALYST IN A NUCLEAR REACTOR. Spitsyn, V. I.; Shulkin, N. I.; Mikhailenko, I. E.; Petrova, O. M. (Inst. of Physical Chemistry, Moscow). *Dokl. Akad. Nauk SSSR*, 171: 907-10 (Dec. 1, 1966). (In Russian).

A study was made of the behavior of alumina-chromia-potassia catalyst under the action of ionizing radiation. A catalyst was chosen having a composition of 90.7 mole % alumina, 5.6 mole % chromia, and 3.7 mole % potassia. It was used in the conversion of n-hexane. The catalyst samples were irradiated in a nuclear reactor with slow neutrons and gamma rays. Experimental data show that irradiation of the catalyst results in significant increases in the yield of benzene. With repeated use of the catalyst the benzene yield remained at a level corresponding to that of the unirradiated catalyst. Irradiation also appeared to affect the selectivity of the catalyst. (JPRS)

SOURCE AND IRRADIATOR DEVELOPMENT

36258 (EUR-3496.e) NON-FUEL APPLICATIONS OF alpha-EMITTING NUCLIDES. Kooi, J. (European Atomic Energy Community). Aug. 1967. 45p. Dep.

Data concerning the application of heavy element α -active isotopes, other than their application as a new nuclear fuel, are reviewed. An attempt was made to extrapolate present data and trends, both from a technological as well as from an overall economic point of view. Attention was drawn to a number of problems that urgently require further study. (auth)

Irradiator Design

34415 IRRADIATION PLANT. (to Sulzer Brothers Ltd.). British Patent 1,075,330. July 12, 1967. Priority date Mar. 11, 1965, Switzerland.

An irradiation facility is described which has at least two source passages for radiation sources. Distribution passages are arranged at one end to communicate with the source passage and at the other end with a rotatably mounted distribution valve. The distribution valve has a passage terminating at one end on the axis of rotation of the valve and the other end eccentric to the axis and positioned to communicate with the other ends of the distribution passages on rotation of the valve. Radiation sources are changed using a source carrier. A locking system prevents the source carrier from being connected or removed from the valve unless the valve is closed. (F.S.)

32304 IRRADIATION PLANT. (to Sulzer Brothers Ltd.). British Patent 1,072,319. June 14, 1967. Priority date Apr. 13, 1964, Switzerland.

An irradiation plant is described which consists of a closed-loop chain conveyor. Two parallel runs are used so that each sample passes the radiation source four times, twice close to the source and twice farther away from the source. The conveyor also has a control system for regulating stops for irradiation and loading and unloading the separate loads on the conveyor. (F.S.)

32334 IRRADIATION APPARATUS. (to Sulzer Brothers Ltd.). British Patent 1,072,074. June 14, 1967. Priority date June 1, 1964, Switzerland.

An irradiation apparatus is described which consists of a radiation source in a radiation-absorbent block, a friction roller-driven piston which extends through the block and has at least two chambers adapted to receive materials to be irradiated and which is mounted to permit the horizontal movement of the chambers into and out of the vicinity of the radiation source. (F.S.)

28146 IMPROVEMENTS RELATING TO IRRADIATION. (to Sulzer Brothers Ltd.). British Patent 1,070,682. June 1, 1967. Priority date Apr. 20, 1964, Switzerland.

An irradiation facility is described which includes means for conveying the material to be irradiated past the source in batches and provides for periodically interrupting the movement of the conveyor by stationary periods. The drive mechanism for the conveyor system is provided by an electric motor having a high switching frequency. A timer having an adjustable dead time is included in the facility. (B.L.M.)

39090 IRRADIATION PLANTS. (to Sulzer Brothers Ltd.). British Patent 1,078,963. Aug. 9, 1967. Priority date Apr. 13, 1964, Switzerland.

An irradiation facility is described which is comprised of a thick-walled chamber for a radiation source and a means of transferring material for irradiation between the chamber and the outside. (J.R.D.)

39110 IRRADIATION DEVICE. Adany, Leon; Reynes, Georges (to Commissariat a l'Energie Atomique). British Patent 1,082,606. Sept. 6, 1967. Priority date Feb. 17, 1964, France.

An irradiation device is described which consists of an irradiation chamber located in a circuit containing the fluid to be irradiated and a radiation source located outside the chamber across from a window through which radiation can pass without being absorbed. The irradiation chamber is a cylindrical tube whose window has the same radius of curvature as the cylindrical tube. Blades are provided for scraping and agitation in the irradiation chamber. A refrigerant fluid is provided to cool the fluid flowing through the irradiation chamber. The refrigerant fluid is contained in a chamber which is defined by the irradiation chamber tube and a jacket which is eccentric with respect to the tube and is on the opposite side of the tube from the window. (F.S.)

39150 IMPROVEMENTS IN OR RELATING TO IRRADIATION UNITS. Jones, Patrick Leonard (to Nuclear Engineering Ltd.). British Patent 1,078,431. Aug. 9, 1967. Filed Apr. 10, 1963.

An irradiation unit is described in which source material is located in an irradiation zone or chamber within a shielding mass. Source material is not withdrawn during loading or unloading of the material to be irradiated. A tunnel is provided in the shielding mass along which the material to be irradiated is conveyed to and from the radiation source material. The tunnel follows a path that curves or changes direction so that radiation does not escape from the shielding mass. The tunnel usually follows a circular path with an access area diametrically opposed to the source material. (F.S.)

45316 DESIGN OF A ^{60}Co LABORATORY IRRADIATION INSTALLATION USING A DISCARDED 1000-CI THERAPY APPARATUS. Markus, Benno; Kasten, Gerhard (Univ., Goettingen, Ger.). *Strahlentherapie*, 133: 459-64 (July 1967). (In German).

The design is described of a ^{60}Co irradiation unit with a fixed beam direction consisting of a cylindrical lead container with a radial opening. The source can be put into working position by certain devices which can rotate and displace the source. Barium-concrete is used to support the protective container. A cavity in this concrete serves as the irradiation space. The material to be irradiated is introduced through a channel with lead cover. The room containing the ^{60}Co unit does not require an additional radiation protection and, thus, limits the control area. Details as well as costs are reported. (auth)

24696 THE WORLD'S FIRST LARGE SCALE CONTINUOUS GRAIN IRRADIATION PLANT, ISKENDERUM, TURKEY. Atom, No. 124, 27-30 (Feb. 1967).

A ^{60}Co gamma irradiation plant was designed to treat 30 tons of wheat per hour, with an absorbed radiation dose of 16,000 rads. Its maximum handling capacity is 50 tons per hour, and barley, rye, and maize can also be treated. It is designed to employ 200,000 Ci of ^{60}Co , but could accommodate 360,000 Ci. The following aspects of plant design and operation are included: cooling, safety, processing costs, control of grain flow, variable speed drive mechanism, and building design. (UK)

24142 CAPACITY AND EFFICIENCY OF DIFFERENT RADIATION SOURCES FOR THE IRRADIATION OF FOOD. Gruenewald, Th; Tuchscheerer, Th. (Bundesforschungsanstalt fuer Lebensmittelrischhaltung, Karlsruhe, Ger.). *Atompraxis*, 13: 107-12 (Mar. 1967). (In German).

Different radiation sources, such as particle accelerators and radioisotopes, are compared as to their possible use for food irradiation. Formulas for the calculation of the needed beam power, the demanded capacity, and the efficiency of planned facilities are presented. Operation of pilot plants by these criteria is described. (auth)

23040 LABORATORY IRRADIATION SOURCE FOR RADIATION CHEMICAL RESEARCH. Drienovsky, P.; Kopunec, R.; Macesek, F.; Mikulaj, V.; Culka, D. (Komensky-Universitat, Bratislava). *Chem. Zvesti*, 21: 182-90 (1967). (In Czech).

An irradiation device with a ^{90}Sr - ^{90}Y source with an activity of $1,160 \pm 116$ mCi is described. The device is designed for radiation-chemical studies of materials in the liquid phase. The dose intensity of this source was determined with a Fricke dosimeter. The concentration of the trivalent iron was established by the spectrophotometric method by use of the molar extinction coefficient at a temperature of 26°C . The values obtained were $4560 \text{ l mol}^{-1} \text{ cm}^{-1}$ at 222.6 nm and $2187 \text{ l mol}^{-1} \text{ cm}^{-1}$ at 304.5 nm . These values were compared with the values obtained previously. In this irradiation device a dose intensity up to $1.5 \times 10^{15} \text{ eV ml}^{-1} \text{ sec}^{-1}$ can be obtained. An approximate calculation of the dose intensity according to the semiempirical relation was given under the assumption that it is a point source so that this intensity was compared with experimentally determined values. (tr-auth)

43116 IMPROVEMENTS IN AND RELATING TO IRRADIATION. (to Sulzer Brothers Ltd.). British Patent 1,084,891. Sept. 27, 1967. Priority date Apr. 14, 1964, Switzerland.

A conveyor system for moving unirradiated material past a radiation source is described. A horizontal feed system roller conveyor moves unirradiated material into the irradiation section. A double closed loop vertical chain conveyor picks up the individual loads of material and moves them past the radiation source. The irradiated material is deposited on a horizontal exit conveyor and discharged from the facility. (L.C.L.)

46298 IMPROVEMENTS IN OR RELATING TO CRYOGENIC APPARATUS FOR LOW TEMPERATURE IRRADIATION. Depierre, Yves; Verdier, Jacques (to Commissariat a l'Energie Atomique). British Patent 1,087,507. Oct. 18, 1967. Priority date Mar. 9, 1965, France.

An apparatus for low-temperature irradiation is described; it comprises a fluid-tight, thermally insulated vessel for containing in its lower portion a bath of cryogenic liquid to be exposed to an intense radiation flux. It also comprises a fluid-cooled heat exchanger, for condensing vapors formed in the bath, which is cooled by the working fluid of a cryogenerator. The working fluid is subjected to a Stirling cycle. The cryogenerator is located in a zone of low irradiation flux and at a level higher than the bath so that the condensed cryogenic liquid returns to the bath by gravity. (M.H.R.)

41093 METHOD OF IRRADIATING ARTICLES. Skala, Stephen Francis (to Western Electric Co., Inc.). British Patent 1,083,285. Sept. 13, 1967. Priority date Nov. 29, 1963, United States.

A method for irradiating articles is described by which the area of a collimated beam of radiation is elongated by bending the beam with a magnetic field and moving the magnetic field longitudinally along the beam. The beam is enlarged to encompass the entire surface of the article by coordinating intermittent or continuous longitudinal movement of the article with the movement of the magnetic field. (F.S.)

41167 ARRANGEMENT FOR TREATING MATERIAL WITH RADIATION FROM A RADIOACTIVE beta-SOURCE. (to Osterreichische Studiengesellschaft Fur Atomenergie GmbH.). British Patent 1,083,464. Sept. 13, 1967. Priority date Nov. 28, 1963, Austria.

A method and arrangement are described for irradiating gaseous, liquid, and solid materials with a β -source. Layers of thin plates of radioactive materials are arranged to surround or to almost surround the material to be irradiated, the smallest distance between two plates being not more than the range of the β -radiation in the material to be irradiated. (F.S.)

41088 IRRADIATION APPARATUS. (to Sulzer Brothers Ltd.). British Patent 1,082,049. Sept. 6, 1967. Priority date Apr. 14, 1964, Switzerland.

An irradiation facility is described which consists of a method for mounting a radiation source, two closed-loop parallel conveyor systems moving in a single plane, a conveyor system for conveying loads to the other two conveyors. The conveyors are loaded and the material is transferred from one conveyor to another in the same direction and in a single working step. (F.S.)

Small Sources

25932 PREPARATION OF THIN SOURCES EMPLOYING SURFACE-ACTIVE COMPOUNDS. Kutsentov, L. M.; Fleisher, V. G. (Ioffe Inst. of Physics and Tech., Leningrad). *Izv. Akad. Nauk SSSR, Ser. Fiz.*, 30: 455-8 (Mar. 1966). (In Russian).

Chemical methods are described for the preparation of α - and β -radiation sources of minimal thickness. The method of direct introduction of cations from an aqueous solution was used for preparing a monomolecular ^{203}Hg source, suitable for detecting electrons with an energy above a few electron volts. Using an HgCl preparation with specific activity (a) = $0.5 \mu\text{C/mg}$, a two-layer source with an activity of $0.042 \mu\text{C/cm}^2$ was prepared. A relatively simple procedure for synthesis of cetyl phosphate, which was used for preparing a monomolecular ^{32}P source in utilizing phosphoric acid with high specific activity, is also described. (P.C.H.)

34413 NEUTRON SOURCES. Fridrich, Bedrich (Inst. for Research, Production, and Uses of Radioisotopes, Prague). *Jad. Energ.*, 13: 205-11 (June 1967). (In Czech).

The more interesting features of the development of new types of neutron sources and of the latest experimental results in the uses of the radioactive sources at The Institute for Research, Production and Uses of Radioisotopes, Prague, are surveyed. (auth)

Power Sources

24857 X-RAY EXAMINATION OF STRONTIUM TITANATE IRRADIATED BY FISSION FRAGMENTS. Rogers, M. D. (Atomic Energy Research Establishment, Harwell, Eng.). *J. Nucl. Mater.*, 22: 223-5 (May 1967).

SrTiO_3 was irradiated by fission fragments and examined by x-ray diffraction methods. The results were used to assess the behavior of SrTiO_3 undergoing self-irradiation by β particles when ^{90}Sr is used. (auth)

26096 PROSPECTS FOR PRODUCTION OF ^{90}Sr AND ^{137}Cs SOURCES IN FRANCE. Courouble, J. M.; Fradin, J. (CEN, Saclay, France). pp 259-64 of Industrial Applications for Iso-

topic Power Generators. Paris, European Nuclear Energy Agency, 1967. (In French).

The increasing interest in the utilization of isotopic generators has led the CEA to attempt to satisfy the source needs during the next few years. The chemical procedure for the extraction of ^{137}Cs and ^{90}Sr is at the point of the construction of a pilot installation for industrial production. Its annual capacity would be a million curies (ELAN project) and the means employed are economical. Since 1961 it has been possible to obtain high activity sources of ^{137}Cs and soon after of ^{90}Sr . These sources are fabricated from fission wastes from French reactors. It will be possible to develop sources from Cs and Sr compounds bought from the United States. (J.S.R.)

26093 POWER SOURCE REQUIREMENTS IN MINIATURIZED ELECTRONIC AND MECHANICAL EQUIPMENT. Vittoz, B. (Univ., Lausanne, Switzerland); Zangger, C. pp 209-14 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

Some general considerations of the historical motivation for the development of miniaturized batteries and of the actual state of the classical and nuclear techniques in this field are reviewed. The respective characteristics of chemical and nuclear batteries and the advantages which a development of nuclear batteries in the power range of 1 μ W(e) to 1 MW(e) might confer in the field of electronic and mechanical microtechniques are presented. An examination of the power units required by mechanical microinstruments, which have been well established for some time and by electronic micro-circuits, which are now beginning to appear on the market and whose development is still going on, leads to the conclusion that the market for miniaturized batteries will be substantially enlarged in the future in the power range from 1 μ W(e) to 1 MW(e). In this power range the cost of the radioactive source for the nuclear batteries appears to be acceptable from the economic point of view. Some fields of application and typical utilizations which could benefit from the increased reliability which instruments based on the combination of nuclear micro-batteries and electronic micro-techniques are likely to possess are discussed. Some factors limiting these applications such as the requirements of economic industrial production and of safety are mentioned. (auth)

6314 (JPRS-42391) USE OF RADIOISOTOPES AS POWER SOURCES. Translated from Nucleus (Paris), 8: 266-70(1967). 9p. (TT-67-33020). CFSTI.

The use of isotopic generators to produce electrical energy is described. Three types of generators are recommended for European use. These are high-power fission product generators combined with conversion equipment for land use; radioisotope batteries for medical and industrial use, and high-performance generators using ^{238}Pu and ^{227}Ac . Economic evaluations of isotopic generators for space and terrestrial applications are made. (F.S.)

34416 RADIOACTIVE CERAMIC SOURCE AND METHOD OF MANUFACTURE. Meyer, Gerard; Michel, Andre (to CEA). British Patent 1,076,335. July 19, 1967. Priority date Oct. 29, 1964, France.

A radioactive ceramic source which can be employed as a heat source in an electrical energy generation is manufactured using ^{90}Sr as the source material with a base of strontium fluorapatite. In preparing the source, the strontium fluorapatite is crushed to a particle size smaller than 50 μ . The crushed product is shaped in an organic binder which disappears on heating. The compacting pressure is 3 tons/cm². After compacting the shape is heat treated for 8 to 12 hrs at 800° to 1600°C to form a very small dense source for spaceship use. (F.S.)

26089 SMALL POWER SOURCES FOR INSTRUMENTATION AND AUTOMATED EQUIPMENT IN DEEP OCEAN ENGINEERING. Jones, R. E. (Naval Civil Engineering Lab., Port Hueneme, Calif.). pp 171-81 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

The work of the U. S. Naval Civil Engineering Laboratory with small power sources for oceanographic instrumentation and automated equipment is outlined. Because the limitations imposed by chemical battery power on long-term data collection have been found to be significant, an alternative power source is needed. The possibility of using nuclear energy to generate power at the very low levels required may offer an economical solution to the problem. The Naval Civil Engineering Laboratory will devise and conduct a test and evaluation program for radioisotope power sources. It is anticipated that work will commence when the first devices are received, probably by November 1966. (auth)

26090 ENERGY REQUIREMENTS IN THE STUDY AND EXPLORATION OF OCEANS. Dumas, J. C. (Musee Oceanographique, Monaco, France). pp 183-90 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967. (In French).

One of the greatest difficulties in oceanographic studies is the necessity of energy transport between the surface and the various exploration machines. Different energy needs are present according to whether the machine is inhabited or not. The energy needs for inhabited machines (bathyspheres, Argyronete, and underwater dwellings) are high and are tabulated. The energy requirements for automatic data gathering instruments are much lower. These are also indicated. (J.S.R.)

26083 DEMANDS ON THE POWER SUPPLIES FOR LONG RANGE TELECOMMUNICATIONS. Ziegler, A. (Siemens and Halske AG, Munich). pp 85-90 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

Long-life energy sources with a minimum of maintenance are desirable for the remote radio relay stations required in long range telecommunications systems. Transistors have reduced the power supply required, and it is also desirable to reduce the size of the power supply equipment. Therefore, there is a strong interest in installing long-life and maintenance-free primary energy sources such as isotopic power generators matched to the power demands of the telecommunications systems. (L.C.L.)

26114 RANKINE CYCLE POWER UNIT OPERATING WITH ISOTOPIC HEAT SOURCES. Bronicki, L. (Ormat Turbines Ltd., Yavne, Israel). pp 589-613 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

A dynamic power conversion module adaptable to isotopic heat sources is described. The concept of a hermetically sealed, Rankine cycle turbogenerator using organic motive fluids both for power and lubrication is presented. A modified Rankine cycle and the selection of a working fluid having high molecular weight plus other characteristics which are the key to good efficiency in small turbines are discussed. Many thousands of hours of continuous high speed operation accumulated during the last three years prove this type of power unit suitable for isotopic power both from reliability and power level aspect. Originally developed for terrestrial conversion of solar heat the units are now manufactured for either solar or conventional heat sources, in the power range of 200 W(e) to 1000 W(e). Units in the power range down to 50 W(e) and up to 10 kW(e) are being developed. The dynamic power conversion modules appear to be particularly suited for coupling with isotopic heat sources. (auth)

26100 THERMOELECTRIC MATERIALS DEVELOPMENT FOR THE RIPPLE PROGRAM. Hare, G. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 331-8 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

A great deal of work has been done in the last decade, particularly in the U.S.A., to develop thermoelectric materials for power generation. A wide range of materials has been investigated and reported, and some have found application in actual generators. Development of thermoelectric materials is still proceeding and although high conversion efficiencies are unlikely to be attained there is the prospect of an improvement on currently available materials which should make the isotope powered thermoelectric generator economically more attractive. The design principles on which the U. K. Atomic Energy Authority's work has been based and the progress towards achieving satisfactory units are described. (auth)

36291 SYSTEM OF ENERGY CONVERSION. (to Societe Europeenne des Semi-Conducteurs). French Patent 1,364,784. May 19, 1964. Filed May 17, 1963.

A nuclear battery comprises two parabolic mirrors, placed against each other. A spherical radioactive heat source, enveloped by a thin W jacket, is mounted in the center of the enclosure formed by the mirrors while a number of photo-voltaic cells are mounted in the medial plane of said enclosure. The jacket is heated by the source to ca 3000°C thereby emitting luminous radiation which is reflected by the mirrors and converted into electrical energy by the cells. (auth)

26095 SUPPLY OF RADIOISOTOPES FOR POWER. Dominguez, G. (Junta de Energia Nuclear, Madrid). pp 241-58 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

In spite of the very large number of different nuclides that occur in the nature or that may be made by the man, the number of them actually useful as practical heat sources is very limited. The decision upon the possibility of using a certain nuclide as a heat source must be taken by applying certain criteria such as: half-life, power density, energy reserve, health hazards, availability, chemical and physical form, and finally, cost and application field. The list of presently useful nuclides is thus reduced to about a dozen (cobalt-60, strontium-90, cesium-137, cerium-144, promethium-147, polonium-210, actinium-227, thorium-228, uranium-232, plutonium-238, curium-242 and curium-244). A survey is made of their preparation methods, properties, and application fields, as well as of their actual or potential availability in Europe (auth)

26088 USE OF RADIOISOTOPIC THERMOELECTRIC GENERATORS IN AIDS TO NAVIGATION IN SWEDEN. Hallengren, L.; Hjertberg, C. G.; Ulvönaes, S. (Swedish National Board of Shipping and Navigation, Stockholm). pp 165-9 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

In order to investigate the possibilities of cutting down the operation costs of small lighthouses in the Swedish archipelago with difficult access, the National Board of Shipping and Navigation decided to install and operate a radioisotopic thermoelectric generator in a lighthouse in the Stockholm area. The investigation is expected to clarify the problems which may arise as a result of the use of isotopic power sources. (auth)

26105 PROBLEMS POSED BY THE STUDY OF A RADIO-ISOTOPIC GENERATOR OF ELECTRICITY FOR SPACE.

Eidelmann, D. (SNECMA, Suresnes, France); Guennoc, H. pp 415-24 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967. (In French).

A study was undertaken to develop a 10 W(e) space generator prototype using a heat source of ^{90}Sr titanate. The conversion of heat into electricity would be made by means of doped Ge-Si thermocouples. In this study various points of view were examined: (1) minimum mass for fixed operational conditions; (2) flexibility of operation higher than a minimum fixed value for the duration considered; (3) structure compatible with admissible norms for various possible accidents; and (4) integration of the generator to the rocket or satellite. The study made considered only the first point of minimum mass for 5-years' operation at 10 W(e). The number of thermo-elements used, the cold temperature of the thermo-element, hot temperature of the thermo-element, materials chosen and arrangement adopted, and geometric form of the radioactive source were the parameters selected in the study. The work program and the first physical measurements in the study are reported. (tr-auth)

26112 STIRLING ENGINE, PRESENT AND FUTURE.

van Witteveen, R. A. J. O. (Philips Gloeilampenfabrieken Research Labs., Eindhoven, Netherlands). pp 525-56 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

A short historical and technical survey of the Stirling engine developments is given. Up to now a number of prototypes have been made ranging up to 100 bhp per cylinder. Test results are reported. They indicate that efficiencies are in the range of well-designed diesel engines (close to 40%). It is shown that improved results (up to 45 or 50%) may soon be expected. Difficulties inherent in the Stirling engine, e.g., the dynamic sealing of hydrogen or helium at 100 atmospheres or more are described. The basic principles of the Stirling cycle and their application in a modern engine are given. The prospects of the Stirling engine in the near future and its special advantages which may even open up new fields of application are discussed. The possibilities for use in the field of nuclear energy, which seem very attractive, are treated at greater length. (auth)

26108 EURATOM'S ACTIVITY ON RADIOISOTOPE POWERED THERMOELECTRIC AND THERMIONIC GENERATORS. Gillot, R. H.; Neu, H.; van Andel, E. (EURATOM, Ispra, Italy). pp 461-82 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

Design studies of generators using a thermoelectric conversion system were carried out for a 5 W(e) generator based on Pb Te thermoelectric couples, powered with a thulium-170 source. A demonstration device of a "sandwich" type (two modules of couples in series on both sides of the flat isotopic source) has been constructed and tested by electrical heating. Some studies have been made on electrode-element bonding. The heat source (in preparation) will be made of 15 small tubes filled with Tm_2O_3 pellets and pressed between metal plates. A parameter study for a 50 W(e) generator with Ge Si elements and an actinium-227 source shows that units with reduced size and weight should be producible for space application. Replacing the thermoelectric system by a thermionic converter has the advantage of a higher thermal efficiency. Parameter and design studies on radioisotope powered thermionic generators show however a rather strong decrease in the efficiency with decreased power output below 50 W(e). The importance of using a new heat transfer system, called heat pipes, for heat removal and heat flux concentration is discussed. (auth)

26087 NOTE ON AUTOMATIC WEATHER STATIONS.

pp 153-5 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

The operational requirements for automatic weather stations are outlined and the range of power source output required is indicated. (auth)

26109 THERMOELECTRIC GENERATOR OF VERY LOW POWER WITH RADIOISOTOPES STUDIED UNDER EURATOM CONTRACT. Brouee, R. (Hispano-Suiza, Boise-Colombes, France). pp 489-92 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967. (In French).

A very small radioisotopic thermoelectric generator (several tenths of a watt) is being developed. The advantages of such a generator are discussed. It should be possible to construct the generator since the techniques were already developed. The applications of a very low power generator are discussed. (J.S.R.)

26115 LOW POWER ENERGY CONVERSION BY CHARGED PARTICLE COLLECTION. Andersson, I. O.; Svansson, I.

(Aktiebolaget Atomenergi, Nyköping, Sweden). pp 619-31 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

The possibilities of using direct particle collection for application as a low power isotope battery are discussed. In spite of the low power available—in the range of some μW —such batteries are of interest specially when a long battery life, small size and a reliable system are required. The principles for the two methods: direct collection of the primary charges and absorption in a semiconductor p-n junction are described including the criteria for the selection of the isotopes which are of main interest. For two of these isotopes, ^{238}Pu and ^{147}Pm , which are respectively pure alpha and beta emitters, calculations are given for the expected output power for some source strengths. The shielding required to reduce the dose rate to acceptable levels is discussed and an estimate of size and reliability is made. The result of experiments with direct collection of beta particles from a ^{90}Sr source is presented and examples are given where this type of low power sources already has found an application. (auth)

26082 POWER REQUIREMENTS FOR SPACE SATELLITES.

Squires, D. M.; Young, R. W. (Hawker Siddeley Dynamics Ltd., London). pp 55-72 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

The European space programs, both at national and international levels, are reviewed, and the requirements for power generation for scientific, military and communication satellites in the next decade are examined. The present and future systems of power generation are discussed and the comparative performance of systems using isotopes examined in relation to the constraints of minimum weight and high reliability imposed on satellite borne equipment. A survey of the types of isotope systems presently under development or projected are discussed. The factors influencing the choice of isotope are presented in the light of the very stringent safety precautions that must be observed both before launch, as a result of failure during launch or in the event of satellite re-entry. The changes in satellite configuration resulting from use of such power systems are also examined. The future of isotopic power generation systems in relation to the European space program is discussed and the development requirements and time scales are examined. (auth)

26113 SURVEY OF THE ISOTOPE FUELED SMALL RANKINE CYCLE POWER UNIT.

Ottesen, R. (Junkers Flugzeug- und Motorenwerke AG, Ger.). pp 557-79 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

Isotope fueled Rankine cycle power conversion plants are discussed. Space achievements and efforts towards a small power unit under development are described. The importance of suitable working fluids, particularly for terrestrial applications, stands in the foreground for cycle considerations, and especially organic fluids are found to give great promise for the special requirements of cycle components. The reliability of these fluids as to thermal stability and irradiation resistance has yet to be verified experimentally. Likewise reliable enthalpy diagrams should be elaborated. The results of a terrestrial system layout showing the overall performance versus plant size are indicated, and suggestions are made how to cope with miniaturized primemovers yet maintaining tolerable system efficiency. If required, outputs as low as 200 watts are within actual reach. Estimating pros and cons of hot and organic cycles seems to favor the organic one. The most important item is the relatively moderate cost of development. A two year research period should be sufficient to establish a fully tested closed-loop pilot plant. (auth)

26111 NUCLEAR STIRLING ENGINE.

H. B. (Reactor Centrum Nederland, Petten, Netherlands). pp 517-24 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

Some general possible design concepts are given for a nuclear heated Stirling engine. Interesting nonconventional application areas are pointed out in a brief review. One special application area for a first prototype is named and some desired specifications are formulated. (auth)

26117 SAFETY ASPECTS OF RADIOISOTOPIC GENERATORS IN SPACE. Bryant, Pamela M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 563-8 of *Industrial Applications for Isotopic Power Generators*. Paris, European Nuclear Energy Agency, 1967.

The potential applications of isotopic generators as sources of auxiliary power in space involve quantities of radionuclides sufficient to produce up to a few kilowatts of electrical power. In abnormal circumstances, expected to arise infrequently, most or all of the activity in the generator could be burned up on re-entry to the upper atmosphere. Prediction of the activity in surface air and in milk which would arise if a single 1 kilowatt generator with any of nine nuclides studied were burned up is based on data from weapons tests. The predicted activities are compared with reference levels derived for the purpose. In the event of burn-up of an isotopic generator in the upper atmosphere, the use of certain nuclides such as plutonium-238 or strontium-90 would present more potential problems than use of the others studied. It appears 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)

39141 RADIOISOTOPES AS POWER SOURCES. OECD (Org. Econ. Coop. Develop.) *Observ.*, No. 24, 49-53 (Oct. 1966).

Development of radioisotope power sources by European nations is reviewed. A series of isotopic generators called RIPPLE (Radio Isotope Power Pulsed Light Equipment), intended to provide power for marine navigation lights, was built in the United Kingdom. These generators provide 2-W power and are now in experimental operation with Xe flash tubes which give light at a range of 2 mi. In France, a low-power demonstration generator is under construction, while Euratom, at its Ispra Center, is building an experimental prototype 5-W unit. Isotopic generators have also been constructed in the USSR. A European Nuclear Energy Agency report has recommended that work should be concentrated on 3 types of isotopic generator: a terrestrial generator of original design with high power (of the order of several electrical kilowatts) using fission products and dynamic conversion machines; a form of radioisotopic battery for medical and other industrial applications; and compact high-performance generators using either ^{238}Pu or ^{227}Ac as heat source. Advantages of the different types are discussed, particularly from economic aspects. Their intrinsic advantages of long life, reliability, and freedom from maintenance make isotopic generators of great potential interest both from the technical and economic points of view. The safety aspects of the various radioisotopic power generators are also considered. (BBB)

26079 INDUSTRIAL APPLICATIONS FOR ISOTOPIC POWER GENERATORS. Joint UKAEA-ENEA International Symposium, A.E.R.E., Harwell, September 1966. Paris, European Nuclear Energy Agency, 1967. 730p. FF 92; FS 84; DM 76,50; £ 6.14s; \$22.00. (CONF-660951).

Forty-four papers on the industrial applications for isotopic power generators are presented. Individual abstracts were prepared for 42 papers. Two papers on power supply requirements were omitted. (L.C.L.)

For abstracts of individual papers see: 26020, 26055, and 26080-26119.

26118 SAFETY CONSIDERATIONS IN THE TERRESTRIAL APPLICATIONS FOR ISOTOPE POWERED GENERATORS. Morley, F. (Atomic Energy Research Establishment, Harwell, Eng.). pp 669-72 of *Industrial Applications for Isotopic Power Generators*. Paris, European Nuclear Energy Agency, 1967.

The potential radiation hazards associated with terrestrial applications of isotope powered generators are summarized and emphasis placed on the need for high standards of containment for generator fuel. It is suggested that safety standards commanding a wide degree of international acceptance are desirable. To a large extent, however, it should be possible to borrow from codes and regulations which have already been developed for general application in the field of radiation safety. Existing regulations governing the safe transport of radioactive materials may be particularly valuable as a basis for the formulation of standards for containment integrity and tests to demonstrate compliance with these standards. (auth)

36292 ELECTRICAL BATTERY WITH A RADIOACTIVE EMITTER ELECTRODE OF TRITIATED GRAPHITE. Adany, L. French Patent 1,384,042. Nov. 23, 1964. Filed Nov. 20, 1963.

A direct-charging nuclear battery is constituted by an emitter electrode of tritiated graphite, a different collector electrode and an ionizable gas, preferably argon, between the electrodes. (auth)

26081 PROSPECTS OF USING RADIOISOTOPES IN SPACE. Contzen, J. P. (European Space Vehicle Launcher Development Organization, Paris). pp 43-54 of *Industrial Applications for Isotopic Power Generators*. Paris, European Nuclear Energy Agency, 1967.

The uses of radioisotopes in space are identified. Attention is concentrated on the two major categories of application: propulsion and electric power generation. A tentative selection of the most suitable isotopes is made for both types of system, and problems which arise from their development are analyzed. Utilization prospects are projected from this analysis, particularly from a European point of view. (auth)

26107 ISOTOPE BATTERY WITH THERMOELECTRIC GENERATOR. Menke, H. H.; Schmidt, E. F. (Allgemeine Elektrizitätsgesellschaft, Hamburg). pp 451-9 of *Industrial Applications for Isotopic Power Generators*. Paris, European Nuclear Energy Agency, 1967.

The requirements of an isotopic battery are low weight, high reliability, and high efficiency. Low weight can be obtained by the use of aluminum, magnesium, and alloys of these elements for the manufacture of construction parts, and the selection of an isotope fuel such that the weight of the radiation shielding is as low as possible. Reliability and high efficiency are a function of the operational temperature. A high temperature differential of the thermocouples is essential to high efficiency of the thermoelectric converters, and, therefore, results in the most economical use of the isotopic heat source energy. However, a high operating temperature decreases the reliability of isotopic batteries due to decreased material strength to resist shock and vibration damage. An optimum operating temperature condition considering both reliability and efficiency must be obtained. Since the construction of an isotopic battery is already technically solved, the application of such systems is but a question of how the costs of the isotopes can be reduced. (L.C.L.)

26091 CATHODIC PROTECTION AGAINST CORROSION AND THE APPLICATION OF ISOTOPE BATTERIES. Kammpermann, H. (Wilhelm Quantz AG, Ger.). pp 191-3 of *Industrial Applications for Isotopic Power Generators*. Paris, European Nuclear Energy Agency, 1967.

Corrosion is considered as an electrochemical process and the basic characteristics of cathodic protection are outlined. The range of possible applications of this technique is mentioned. Electric power supply requirements are assessed, with particular reference to cost of supply, and power supply problems in remote areas considered. Examples of apparatus and protection systems are given. (auth)

28173 LIMITS OF THE RANGE OF APPLICATION OF RADIOISOTOPE SOURCES AND NUCLEAR REACTORS AS ENERGY SOURCES FOR SPACE VEHICLES. Einfeld, K.; Lauffner, R. A. (INTERATOM, Bensberg, Ger.). pp 135-49 of *Energieversorgung im Weltraum*. Würsthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketen- und Raumfahrt e.V., 1966. (In German).

The applicability limits of reactor and radioisotope systems should be defined with respect to their output. In addition to shielding and safety requirements, power, weight, and system costs are to be considered in the transportation cost of different carrier rockets. Radioisotopes are therefore considered in this respect on the basis of their physical properties, availability, cost, and shielding and safety requirements. The characteristic variations of both energy sources were discussed. Three power ranges are indicated from which only the middle range with initial power of several hundred watts up to several kW were considered under sharply limited assumptions on both nuclear power systems. (tr-auth)

26098 EXPERIENCE WITH OPERATING RADIOISOTOPE-FUELED THERMOELECTRIC GENERATORS. Morse, J. G. (Hispano-Martin, Bois-Colombes, France). pp 285-99 of *Industrial Applications for Isotopic Power Generators*. Paris, European Nuclear Energy Agency, 1967.

Continuing and increasing needs for small reliable sources of electrical power led the U.S.A.E.C. in 1956 to contract with Martin Company, to explore the feasibility of producing electrical energy from the decay heat of radioisotopes. The resulting program, called SNAP (Systems for Nuclear Auxiliary Power), has engendered a new technology encompassing the use of radio-nuclides coupled with static thermoelectric converters as unique sources of compact, long-lived power. In addition, all hardware produced and under development reflects detailed and thorough analyses and tests of nuclear safety characteristics peculiar to the operational use of the device. SNAP developments in terms of their end use, and the evolution of design towards modularization of thermoelectric converters are discussed. The reliability and performance of the system and future engineering needs for continued growth of this technology are described. (auth)

26119 ECONOMIC ASPECTS OF ISOTOPIC GENERATORS. Pollock, J. F. (Atomic Energy Research Establishment, Harwell, Eng.). pp 679-88 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

Indications are given of the probable cost of isotopic power generators and an attempt made to define the economic power range. A comparison with alternative power sources is made. Outline proposals are made for revenue as against capital expenditure to avoid the heavy initial outlay. An indication is given of developments which could reduce the present cost of isotopic power. (auth)

26085 ISOTOPIC THERMOELECTRIC GENERATORS FOR THE SUPPLY OF POWER TO SUBMERGED REPEATERS IN SUBMARINE TELEPHONE CABLE SYSTEMS. Foot, G. H. (Submarine Cables Ltd., Greenwich, Eng.). pp 99-114 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

A detailed study is presented of the requirements for individual power sources for submerged repeaters in submarine telephone cable systems. These requirements include unvarying power supply for a continuous period in excess of 20 years without the necessity of maintenance or access, a reliability equivalent to the failure of not more than one unit in 400 over that period, and competitively low cost. With reduced power consumption due to transistorized repeaters, it may be possible to construct isotopic generators to satisfy these requirements. The problems of designing a suitable generator and a description of a generator now under construction are given. (L.C.L.)

26099 UKAEA RIPPLE PROGRAM. Yeats, F. W. (Atomic Energy Research Establishment, Harwell, Eng.). pp 309-29 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

An investigation was made of various methods of directly converting heat to electricity which could be used in conjunction with nuclear power. Thermoelectric conversion with radioisotopes as the source of primary heat energy was considered. The work resulted in the conception of the RIPPLE type of isotopes-powered thermoelectric generator in which ^{90}Sr is the heat source. Possible applications of isotopic generators are reviewed, and it was concluded that the main terrestrial market would be for marine navigation lights. Two demonstration generators for this purpose were developed and exhibited, and a third prototype device is being laboratory tested. (L.C.L.)

26086 PROSPECTS FOR THE USE OF ISOTOPIC POWER SOURCES IN CIVIL AVIATION COMMUNICATIONS AND NAVIGATION SYSTEMS. Clark, J. O. (British Overseas Airways Corp., Eng.); Whiddett, S. D.; Meadows, R. C.; Young, R. A. pp 123-45 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

The significance of the civil air transport system is outlined with particular reference to the use of advanced technology. An analysis is made of the use of power sources for civil aviation communication and navigation aids. Both airborne and ground environments are considered providing an indication of the facility operational requirements and consequent power levels. The significance of the freedom presented to communication and navigation facility siting by long-life radioisotope power generators is emphasized. Specific proposals are made for the evaluation of a navigation equipment presently available in the U.K. at both U.K. and overseas sites, allowing an analysis of operational and economic implications. (auth)

26094 USE OF RADIONUCLIDE BATTERIES TO POWER ELECTRIC AND ELECTRONIC CLOCKS. Kuner, S. (Kieninger und Obergefell, St. Georgen/Schwarzwald, Ger.). pp 215-34 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

During the past ten years the electric battery clock has been widely used as a so-called domestic clock and has thus largely supplanted the classical clock with mechanical winding. In addition the electronic clock characterized by its reliability and high accuracy has met with a ready market. In this connection, the need for a long-lived, safely operating power source to drive electric and electronic clocks was discussed and it was natural that interest preferably turned towards atomic energy. Therefore, the problems and technical requirements of using nuclear batteries to power electric and electronic clocks are reviewed, and potential solutions to these problems given. (auth)

26080 INTRODUCTION TO ISOTOPIC GENERATORS. Dunn, P. D. (Univ. of Reading, Eng.). pp 31-9 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

The nature of direct conversion processes is outlined with special reference to isotopic heat sources and the different methods of converting heat to electricity. Possible applications for different types of isotopic generators are reviewed. (auth)

28172 ENERGY SUPPLY INSTALLATIONS WITH NUCLEAR ENERGY SOURCES. Pruschek, R. (Technische Hochschule, Stuttgart). pp 103-33 of Energieversorgung im Weltraum. Wursthorn, Armin M. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. (In German).

The properties of nuclear energy sources such as radioisotopes and nuclear reactors are described with respect to their applicability as energy supply sources for space craft. The properties of various energy converters and the problem of their construction together with the nuclear heat source are discussed. The present state of nuclear energy power sources and the development tendencies were considered. (tr-auth)

26116 PHOTOELECTRIC RADIONUCLIDE BATTERY AND ITS LIMITS. Scharman, A. (Univ., Giessen, Ger.). pp 645-53 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

The production of electricity using the combination radionuclide-luminophor-photoelement is reported. Based on the results of experiments, the principal limits of such a device are discussed. Batteries of this type can be used, preferably in the microwatt range. (auth)

39132 (RCC-R-195(Rev.)) TESTING THE SOURCE CAPSULE FOR THE RIPPLE III GENERATOR FOR APPROVAL AS "SPECIAL FORM" (I.A.E.A. TRANSPORT REGULATIONS).

Ansell, K. H. (Radiochemical Centre, Amersham (England)). Dec. 1966. Revised June 1967. 14p. Dep. CFSTI. UK 2s. 6sd.

The RIPPLE III source was the first capsule to be approved in the UK as "special form." The tests necessary to obtain this certificate of approval are described. (auth) (UK)

26084 NOTES ON THE POSSIBILITY OF UTILIZING ISOTOPIC THERMOELECTRIC GENERATORS FOR POWERING TELECOMMUNICATIONS EQUIPMENT. Sawyer, L. R. (GEC (Telecommunications) Ltd., Coventry, Eng.). pp 91-8 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

The power requirements for microwave radio relay stations in a communications system between main centers of population with large areas of undeveloped territory intervening are outlined. An indication is given of the factors which have to be considered in assessing the merits of isotopic power generators as compared with a diesel generator power supply. (auth)

26106 DEVELOPMENT OF A RADIOISOTOPE THERMOELECTRIC POWER GENERATOR. Zahn, P. (Boelkow GmbH, Otobrunn, Ger.). pp 435-50 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967.

The status of the development work of a thermoelectric conversion system is outlined and a special compact GeSi-converter element is presented. With these elements an actual model of a space power generator with an electrical output of 125 W was constructed. The model was subjected to vacuum tests with an electrical simulated heat source. In addition, an outlook is given on the future performance characteristics of radioisotope thermoelectric power generators. (auth)

28138 ENERGIEVERSORGUNG IM WELTRAUM. Herausgegeben von der Deutschen Gesellschaft fuer Raketentechnik und Raumfahrt e.V., Stuttgart, 8 Dezember 1965. (Symposium on Energy Production in Space. German Society for Rocket Technology and Space Travel, Stuttgart, December 8, 1965). Wursthorn, Armin M. Fortschritte in der Raumfahrtforschung, Band 2. Munich, Deutsche Gesellschaft fuer Raketentechnik und Raumfahrt e.V., 1966. 285p. \$7.00. (CONF-651219).

The 14 papers presented at the symposium on energy production in space at Stuttgart are compiled. Individual abstracts were prepared for 11 papers. (J.S.R.)

For abstracts of individual papers see: 28139, 28172, 28173, 29079-29085, and 30241.

26020 MARGUERITE, A RADIOISOTOPE MARITIME GENERATOR. Stoll, R. (CSF, Puteaux, France); Freund, J. pp 425-9 of Industrial Applications for Isotopic Power Gen-

erators. Paris, European Nuclear Energy Agency, 1967. (In French).

A generator prototype using radioisotopes and thermoelectric conversion of low power was developed. This type generator is used as the source of electric power for maritime detection devices. The principal characteristics of Marguerite are tabulated. (tr-auth)

36290 ELECTRICITY GENERATING GROUP, FED BY ATOMIC ENERGY. (to F. Arbel and Cie). French Patent 1,238,232. July 4, 1960. Filed Feb. 28, 1958.

A thermo-electric nuclear battery is described consisting of a shielded rod of radioactive material that is encircled by a number of annular thermopiles, the hot junctions of which contact the rod while the hot junctions are provided with protruding cooling fins. One or more of these assemblies are mounted in a tube through which a coolant gas passes. (auth)

26103 THERMIONIC ISOTOPIC GENERATOR WITH ^{238}Pu . Clemot, M.; Devin, B.; Durand, J. P.; Semeria, J. (CEN, Saclay, France). pp 383-97 of Industrial Applications for Isotopic Power Generators. Paris, European Nuclear Energy Agency, 1967. (In French).

The general arrangement of a thermionic converter suitable as an auxiliary power source is described. The description includes the caloduct system for the emitter and for the collector. The energy source is ^{238}Pu and the generator is designed to furnish 50 W. (tr-auth)

SAFETY

28144 HOT LABORATORIES. D'Arcy, J. (ed.). London, British Nuclear Forum, 1966. 44p.

The following topics are covered: philosophy of hot laboratories, shielding, glove boxes, remote handling, viewing, monitoring, ventilation, decontamination, waste handling, and in-cell equipment. (UK)

30758 DISPOZITIVE SI CIRCUITE ELECTRONICE IN INSTALATI CU IZOTOPI RADIOACTIVI. (Electronic Devices and Circuits in Installations Provided with Radioactive Isotopes). Cristea, Gh.; Grecescu, M.; Ionescu, G.; Ionescu-Muscel, C.; Popescu, Al.; Racoveanu, N.; Stan, S.; Tarina, E. Bucharest, Editura Tehnica, 1965. 616p.

The application of radioisotopes requires in most cases the use of specially designed electronic devices; in addition, health physics instrumentation must be made available for the protection of the workers. A review of the problems associated with such instruments and their circuitry is presented as a textbook. In order to make it more generally available the mathematical material was kept to a minimum, although it was assumed that the reader is familiar with electronic circuits based on tubes and transistors. The 19 chapters are organized in three main parts: Chapters 1 to 6 review the physical basis of the application of radioisotopes and the operation of the control instruments used. Chapters 7 to 14 present the principles of operation of electronic circuits; including radiation detectors, d-c and pulse amplifiers, amplitude discriminators, pulse generating circuits, coincidence and anticoincidence circuits, pulse counters, and stabilized supply sources. Chapters 15 to 19 present the most important currently available instruments fabricated in Rumania and abroad describing industrial instruments based on the use of radioisotopes, including γ scintillation spectrometers, instruments using nuclear radiation transducers, diagnostic devices, and health-physics instruments, emphasizing instruments using isotopes manufactured in Rumania. (470 references) (TTT)

24422 (NRC-TT-1264) RADIATION HAZARDS IN WORK WITH ISOTOPES. Lindell, Bo. Translated by H. Nathan (National Research Council of Canada, Ottawa), from Lakartidningen, 62: (42): 3447-57(1965). 19p. JCL \$1.60 fs, \$0.80 mf.

Acute, genetic, and cancerogenic efforts of radiation are reviewed. Hazards of occupational exposure to radioisotopes are discussed with emphasis on the maximum permissible dose concept, and measures for radiation protection of personnel in Sweden are considered. (H.G.D.)

36329 RECENT DEVELOPMENTS REGARDING THE REGULATIONS FOR THE TRANSPORT OF RADIOACTIVE SUBSTANCES. Failla, L. (CNEN, Rome). G. Fis. Sanit. Prot. Radiaz., 10: 111-13 (Apr.-June 1966). (In Italian). (RT/PROT (67)2).

During the last two years, IAEA and CIM (International Convention for the transport of goods by rail) have reappraised, in some respects radically, the regulations concerning the transport of radioactive materials. These regulations are mainly security regulations in that they especially regard the prevention of accidents and the limitation of the damage which could follow them, but also involve the field of health protection against radiations, although they do not always supply a complete solution for the health problems involved. The author aims at stressing some of the main features of these regulations as regards protection, and at describing their evolution. (tr-auth)

26136 CALCULATION OF THE SHIELD OF A SPENT-FUEL SHIPPING CONTAINER. I. Hoehn, J. (VEB Kombinat Kernenergetik, Berlin. Buero fuer Entwicklung und Projektierung Kerntechnischer Anlagen, Berlin). Kernenergie, 10: 14-20 (Jan. 1967). (In German).

The shield of a shipping container for spent fuel elements was calculated. Depleted nuclear fuel (UO_2 enriched with ^{235}U) was stored for half a year in the storage tank after burnup in the reactor for two years. The calculation was based on doses at the surface of the container with consideration of international regulations. The complex geometry of shielding due to the design of the container was approximated physically in such a way that using an electronic computer for numerical evaluations is not necessary. (auth)

30674 TECHNICAL AND PRACTICAL DESIGN OF EXPENDABLE PACKAGING FOR RADIOISOTOPES. Vinarnick, L. Bull. Inform. Sci. Tech. (Paris), No. 115, 25-35 (May 1967). (In French).

The importance and the purpose of expendable packaging for radioisotopes, particularly with respect to the returnable type are described. The component parts are also described. Selection criteria, measurement methods, and the type B packing container are then described. (auth)

30667 HEAT PROBLEMS ENCOUNTERED IN RESEARCH ON PACKAGING. Lenail, B.; Lucas, H.; Merle, J.-P. Bull. Inform. Sci. Tech. (Paris), No. 114, 53-71 (Apr. 1967). (In French).

After a brief outline of the statutory obligations and a review of the risks, the method of conducting calculations is described for packaging designed for transport of radioactive materials. Under normal conditions with the main source of heat being the residual power of the fuels, the temperatures of the cask and those of its contents are calculated step by step from the external temperatures; the methods used to lower the temperatures are mentioned briefly. Under temporary conditions (accidental conditions of fire) the problems encountered and the methods used to solve them are described. (auth)

30676 CONSTRUCTION OF PACKING CONTAINERS FOR RADIOACTIVE MATERIALS. Labrousse, M.; Remy, J. Bull. Inform. Sci. Tech. (Paris), No. 115, 3-24 (May 1967). (In French).

An outline is given of the main factors, statutory in particular, which must be taken into consideration when a packing project is being established. The resulting problems are listed and on a few special points the possible solutions are given, with emphasis in certain cases on the economic factors involved. (auth)

32341 IMPROVEMENTS IN OR RELATING TO SEALED CONTAINERS AND TO METHODS OF AND APPARATUS FOR TESTING FOR LEAKS THEREFROM. Hayes, David John (to Central Electricity Generating Board). British Patent 1,071,794. June 14, 1967. Filed Aug. 31, 1964.

A method and the equipment used for leak testing a sealed container are described. A radioactive gas, preferably ^{85}Kr , is inserted into the container before sealing. The presence of the radioactive gas is measured with a thallium activated NaI scintillation detector. The radiation of the ^{85}Kr which penetrates the walls of the container is measured, and with the container in a chamber with reduced pressure, the radioactivity which has leaked into the chamber is measured with an organic scintillation detector. This method is applicable for automatically leak testing reactor fuel elements in which the fuel material is sealed in a can. (F.S.)

30668 HISTORY OF THE TRANSPORT OF RADIOACTIVE MATERIALS IN FRANCE. Capet, H.; Bouillet, J. Bull. Inform. Sci. Tech. (Paris), No. 114, 7-10 (Apr. 1967). (In French).

The problem of transporting radioactive materials in France is reviewed. Regulations, their extent and their effects are discussed along with industrialization of the transports. Technical research in packaging methods and economics for the future are also discussed. (P.C.S.)

30675 TRANSPORTATION PROCEDURES OF THE C.E.A. Bourdier, F. Bull. Inform. Sci. Tech. (Paris), No. 115, 37-43 (May 1967). (In French).

In view of the risks involved in the transport of radioactive materials, it has been necessary to decree a certain number of safety regulations in order to cut down the probability of an accident and, if one should occur, to limit the consequences. The practical procedures of a general nature which the user can find in the decree of July 1, 1966 (road and rail), and the procedures specific to Commissariat transports are examined. In conclusion the procedure is shown to be well founded since of 21,000 transports carried out in 9 years, not one accident caused by radioactivity has been recorded. (auth)

34142 SPANISH NUCLEAR LEGISLATION. Lasurtegui, Alfonso de los Santos. Energ. Nucl. (Madrid), 10: 509-18 (Nov.-Dec. 1966). (In Spanish).

A brief chronological review is given of the enactments promulgated in Spain with respect to nuclear energy. (J.S.R.)

30342 LAW RELATING TO NUCLEAR ENERGY. Street, H.; Frame, F. R. London, Butterworths, 1966. 320p. 110s.

Topics covered include: organizations in the U. K., licensing of nuclear installations in U. K., civil liability arising before 1965 from operation of nuclear installations, civil liability arising after 1965 from operation of nuclear installations, use of radioactive materials, transport of radioactive materials, international organizations, liability arising from operation of nuclear installations outside U. K., nuclear ships, patents, and statutes and conventions relating to nuclear energy. (UK)

MISCELLANEOUS

42545 RADIONUCLIDE NEUTRON SOURCES IN TEACHING NUCLEAR CHEMISTRY. Tel'deshi, Yu.; Varga, Sh.; Dillinger, P. (Bratislav Polytechnic Inst.). Jad. Energ., 13: 253-64 (July 1967). (In Czech).

Descriptions are given of neutron radiation installations available on the market and designed at the university. Data are presented on the radiation parameters of the devices and reactions of the neutron radiation with the substances and neutron detectors. The use of radioisotopic sources of neutron radiation in nuclear chemistry studies is discussed. (tr-auth)

43202 RADIOISOTOPE EXPERIMENTS FOR SCHOOLS AND COLLEGES. Dance, J. B. Oxford, Pergamon Press, 1967. 212p. 17s. 6d.

Section headings are as follows: fundamentals; measurement of nuclear radiation; naturally occurring radioisotopes; health physics; some practical considerations; some demonstration experiments; experiments using naturally occurring radioisotopes; experiments using sealed sources; and experiments using unsealed artificially produced isotopes. (UK)

26071 FIXATION OF PHOTOELASTIC FRINGE PATTERNS BY GAMMA RAYS. Miyazono, Shohachiro (Japan Atomic Energy Research Inst., Tokyo). J. Appl. Phys., 38: 2319-23 (Apr. 1967).

It is shown that photoelastic fringe patterns may be preserved at room temperature by γ -ray irradiation of loaded specimens. The samples used in this experiment were prepared from a mixture of epoxy resin and curing reagent (hardener) of the weight ratios of 100 to 12. The effect of irradiation curing was also studied as a function of the irradiation dose and the concentration of the curing reagent. It was seen that the fringe patterns are retained nearly 100% if the total dose is about 2.0×10^8 R. As an example, a bending test is shown. (auth)

22834 INVESTIGATIONS ON THE STERILIZATION OF CULTURE SOILS. Ernst, D.; Glubrecht, H. (Technische Hochschule, Hanover). pp 163-7 of Biophysikalische Probleme der Strahlenwirkung. Muth, H. Stuttgart, Georg Thieme Verlag, 1966. (In German).

The question of whether bacteria and fungi or earth enzymes are responsible for the lime nitrogen (calcium cyanamide) transformation processes in soil or whether the process is a purely inorganic reaction was investigated using radiosterilization. The sterilization and dosimetric techniques used are outlined. The results showed that colony formation after radiosterilization of the soil decreases exponentially with the radiation dose. The results further indicated that 50 to 80% of the calcium cyanamide transformation is caused by bacteria and the rest is caused by earth enzymes. Sterilization with steam or ethylene oxide brings this transformation reaction almost completely to a stop. (J.S.R.)

28174 PREPARATION OF THE ^{86}Kr ISOTOPE LAMP. Tako, Toshiharu (National Research Lab. Metrol., Tokyo). Keiryō Kenkyū-Sho Hokoku, 16: 52-7 (Jan. 1967). (In Japanese).

The procedures and practices involved with production of the Kr-86 hot cathode lamps used as primary standards at the National Research Laboratory of Metrology are described. (TSS)

41415 THE USAGE OF RADIOACTIVE LUMINOUS COMPOUND AND THE NEED FOR BIOLOGICAL MONITORING OF WORKERS. Vennart, J. (Radiological Protection Service, Sutton, Eng.). Health Phys., 13: 959-64 (Sept. 1967).

The use of radioactive luminous paints gives rise to irradiation of luminisers and the public using the luminised articles. As far as the public is concerned, radionuclides which do not emit penetrating radiations, such as tritium and promethium-147, are more suitable materials than radium. Experience in the United Kingdom of monitoring luminisers for radium and tritium in their bodies is reviewed and discussed in relation to the possible use of promethium-147. Present conditions in the luminising industry

are such that there is a need for regular monitoring of workers, and the problems created by tritium and promethium-147 are sufficient to restrict their use, probably in favor of radium. There is thus a conflict between what is desirable from the point of view of the public and what is practiced by the industry. In order to resolve this dilemma it is suggested that the methods employed for luminising should be brought up to much higher standards for containing the radioactive compounds. (auth) (UK)

36283 LUMINOUS SOURCE WITH RADIOACTIVE RADIATION SOURCE. (to Trilux-Lenze K.G.). French Patent 1,336,500. July 22, 1963. Priority date Sept. 27, 1961, Germany.

A luminescent light source in which the activating agent is a gamma source is described. The luminescent material is carried by supporting means which are capable of converting gamma radiation into a softer radiation (e.g., ultraviolet light) by means of the Compton effect, this softer radiation provoking the luminescence. 9 embodiments are described. (auth)

36285 IMPROVEMENTS IN LUMINOUS SOURCES. (to Saunders Roe and Nuclear Enterprises Ltd.). French Patent 1,382,982. Nov. 16, 1964. Priority date Sept. 25, 1962, Great Britain.

An auto-luminescent light source, consisting of a spherical glass bulb, coated on the exterior with a reflector and on the interior with luminescent material is described. The bulb is filled with tritium and provided with an aperture in which a lens is mounted. To increase the light intensity an additional luminescent body, consisting of one or more transparent support plates coated with luminescent material, is mounted inside the bulb. (auth)

36286 LUMINOUS SOURCES. (to Saunders Roe and Nuclear Enterprises Ltd.). French Patent 1,373,843. Aug. 24, 1964. Priority date Sept. 8, 1962, Great Britain.

A method for uniformly coating the interior surface of a glass bulb with a luminescent material that can be activated by beta radiation is described: The surface is first dusted with powdered phosphor. The bulb is then filled with a solution of H_3PO_4 in ethyl ether and quickly emptied. The ether is almost completely evaporated with hot air and the surface again dusted with powdered phosphor. Finally the bulb is heated to convert H_3PO_4 into $\text{H}_4\text{P}_2\text{O}_7$ which firmly fixes the powder. (auth)

30644 METHOD FOR PRODUCING A RADIATION LUMINOUS BODY. Murayama, Yoshihiko (to Nemoto Tokushu Kagaku Co., Ltd.). Japanese Patent 1966-8216. Apr. 28, 1966. Filed Mar. 20, 1962.

A stable and safe radiation luminous body was prepared by mixing 5 to 10 wt % of CdS with ZnS and adding 0.001 to 0.01 wt % of Cu and Ag or Au to the mixture as the activation substance. A mixture of Na, K, Ba, Mg, and ammonium chlorides was added to the other mixture. The whole was heated to a temperature at which the crystal nuclei are formed. After cooling, the mixture was crushed, and NH_4Cl added, and the crystal grown by heating to over 1000°C to obtain the fluorescent zinc cadmium sulfide crystal. The crystal was then coated with a thin film of potassium silicate which was reacted with $^{147}\text{PmCl}_3$ to form a film of insoluble promethium silicate adhering to the surface of the crystal. The film was then dried and coated with a silicone resin. (TSS)

22011 USE OF COMPUTERS FOR RADIOCHEMICAL ANALYSIS. Muenzel, H. (Kernforschungszentrum, Karlsruhe, Ger.). *Chimia (Aarau)*, 21: 125-9 (Mar. 15, 1967). (In German).

The usefulness of the application of radiochemical methods in analytical chemistry depends quite often on the ability to determine the activity of the single components in a mixture of radionuclides. One way to solve this problem is to analyze the gamma spectra or the decay curve of the sample. The graphical methods normally applied for this evaluation of the data show some drawbacks, which could be avoided by using numerical methods. But numerical analysis of the measured data is so elaborate that electronic computers must be used. It is now possible to calculate the γ -energy, and relative intensity or half-lives, and the activity of the components by a least square fit. In addition to the very good accuracy of the results and the high speed of the analysis, the use of the computer for the evaluation of the measured data turns out to be rather economical. Depending on the problem the price per analysis amounts to \$0.50 to \$40.00. (auth)

27927 YADERNO-FIZICHESKIE METODY KONTROL'YA VESHCHESTVENNOGO SOSTAVA. YADERNYE REAKTSII I AKTIVATSIONNYI ANALIZ. (Nuclear-Physical Methods of Material Composition Control. Nuclear Reactions and Activation Analysis). Plaksin, I. N.; Starchik, L. P. Moscow, Izdatel'stvo Nauka, 1966. 204p.

The rapidly developing trend of instrumental analysis—nuclear physical control methods is considered. The use of nuclear reactions with charged particles, neutrons, and γ -quanta and the subsequent activity for determination of composition of ores and their processing products are examined. (tr-auth)

40935 (CONF-661044) ARBEITSTAGUNG ANGEWANDTE RADIOAKTIVITAET, LEIPZIG, 11. BIS 14. OKTOBER 1966. (Symposium on Applied Radioactivity (Radiation), Leipzig, October 11-14, 1966. (Deutsche Akademie der Wissenschaften zu Berlin (East Germany). Institut fuer Angewandte Radioaktivitaet). 154p. (In German). Dep.

The three invited papers at the Symposium on Applied Radioactivity are presented in full. These discuss radionuclides in science, the application of tracer isotopes for methodical studies in the chemical and metallurgical industries, and the chemistry of hot atoms. Abstracts of papers presented to the various sections are compiled. The topics discussed are radiochemical analysis, physical analysis methods with radioisotopes, tracer studies in chemical kinetics, metrology, labeling, and special applications of radioisotopes. (J.S.R.)

45310 (TID-23737, pp 87-113) ISOTOPE TECHNIQUES IN HYDROLOGY. Working Group Meeting held at Grenoble, France, 25-28 October 1965. (International Atomic Energy Agency, Vienna (Austria)).

In connection with research programs jointly sponsored by the AEC and the Bureau of Reclamation, a Bureau representative traveled to Grenoble to participate in a 4-day working group meeting on the isotope techniques in hydrology. The discussions were of an informal type emphasizing recent developments and current problems, and covered such applications as radioisotopes flow measurement in streams and canals, reservoir leakage, ground-water tracing, sedimentation studies, soil density and moisture measurements, and meteorology. Subsequent to the panel meeting, selected visits to organizations concerned with, or performing, flow measurements in high-head turbines and the general engineering applications of radioisotopes were made. A great deal was learned of work being done in flow measurements of radioisotopes at the EDF laboratories at Chatou and the Wantage Laboratory in Great Britain. (auth)

45054 RADIOACTIVE TRACER METHODS IN INORGANIC TRACE ANALYSIS: RECENT ADVANCES. A REVIEW. McMillan, J. W. (Atomic Energy Research Establishment, Harwell, Eng.). *Analyst*, 92: 539-48 (Sept. 1967).

The subject is reviewed under the following headings: introduction; isotopic methods, including single isotope dilution, substoichiometric isotope dilution, isotopic-exchange methods, and concentration-dependent distribution methods; nonisotopic methods, including isotope-derivative and derivative-dilution methods, isotope-displacement methods, and radio-release methods; radiometric titration; and assessment of the practical utility of radiometric methods. (auth) (UK)

25810 CHEMICAL ANALYSIS OF RADIOACTIVE MATERIALS. Lavrukina, A. K.; Malysheva, T. V.; Pavlotskaya, F. I. International Scientific Series. Cleveland, Chemical Rubber Company Press, 1967. 394p. \$13.25.

Translated from *Radiokhimicheskii Analiz* by Scripta Technica, Ltd.

The contents of the book are divided into 5 sections. The first two sections are devoted to the theoretical aspects of the field covering the state and behavior of radioelements in solution and the theoretical bases of radiochemical analysis. The third section deals with the identification of isotopes. The two concluding sections provide a detailed description of specific procedures including the isolation and concentration of the radioelements and methods of isolating individual elements in the radioactively pure state. (B.L.M.)

21905 RADIOCHEMICAL METHODS IN ANALYTICAL CHEMISTRY. III. CHEMICAL AND RADIOCHEMICAL APPLICATIONS OF THE MOESSBAUER EFFECT. Zahn, U. (Technische Hochschule, Munich). *Chimia (Aarau)*, 21: 145-68 (Apr. 13, 1967). (In German).

The electron density and the electric field gradient at the nucleus in a crystal can be deduced from the isomer shift and the quadrupole splitting of a recoilless emitted γ ray. These properties allow an identification and a detailed discussion of the bond structure in many compounds. Chemical effects of nuclear reactions and nuclear transformations are also detectable by the structure of the recoilless emission spectrum. The basic principles of these applications are discussed and illustrated by a few typical measurements. (auth)

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