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Vol. 2
UC-10 – Chemistry-Separation Processes for Plutonium and Uranium

BIBLIOGRAPHY ON NUCLEAR REACTOR FUEL REPROCESSING AND WASTE DISPOSAL

Volume 2

Fission Product, Poison, and Radioisotope Removal

T. F. Connolly

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OAK RIDGE NATIONAL LABORATORY
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PROCESSING OF NUCLEAR REACTOR FUELS – A BIBLIOGRAPHY

Introduction

This volume includes Section 2.0 of eight sections of a bibliography on nuclear reactor fuel reprocessing and waste disposal. The collection will be a unit, and cross references are made between volumes. The decimal coding of headings is designed for ease of cross referencing, filing, expansion, and for future use in an automatic microfilm viewer-printer now being developed.

Cutoff points are somewhat arbitrary: overlapping into the area of feed materials, for example, is kept to a minimum, even though fuel reprocessing and fuel refabrication can be a continuous operation. Continuous on-site reprocessing of aqueous reactor fuels is only lightly covered.

Section 1.0, Chemistry and Physics of Important Elements, contains many references to separation methods and conditions, particularly on a laboratory scale. Cross references to that section from Sections 2.0, 3.0, and 6.0 – to each of which it may be considered as peripheral – would be too numerous to be included and should be assumed for each element. Special tests or uses (e.g., as construction materials or reagents in standard processes) are treated in the appropriate sections.

The complete collection includes about 7000 abstracts, nearly all from Nuclear Science Abstracts, representing books, bibliographies, symposia, journals, and contractors' topical reports. Most of the material dates from the 1955 Geneva Conference to the present. A serious lack is material from progress reports, and a program for the detailed abstracting and indexing of progress reports is therefore under way at ORNL (with the helpful cooperation of the Cataloging Section of the AEC-TISE).

FISSION PRODUCT, POISON, AND RADIOISOTOPE REMOVAL 2.0

Material in this section is divided according to elements and methods. Where more than one element is considered in an abstract the abstract is filed under the appropriate method unless special interest in a particular element dictated otherwise. More general treatments of the methods listed here will be found in Section 6.0, Process Chemistry and Engineering. Where the separate steps listed here are parts of more extended processes they are cross referenced to special processes in Section 6.0. Also, in those cases where the extraction of certain radioelements is more usually considered as incidental to the recovery of certain fissionable materials, these radioelements are treated either in Section 3.0 under Fissionable Material – Recovery or, when appropriate, under the special processes (e.g., Thorex) listed in Section 6.

Because Sections 3.0 and 6.0 deal with the more extended and often more completely integrated processes, evaluations of applications of the methods touched upon here will appear only in those sections.

The main sections of the complete bibliography are:

1.0 Chemistry and Physics of Important Elements
2.0 Fission Product, Poison, and Radioisotope Removal
3.0 Fissionable Material – Recovery
4.0 Hazards and Protection
5.0 Plants and Equipment
6.0 Process Chemistry and Engineering
7.0 Surveys
8.0 Waste Disposal

FISSION PRODUCT, POISON, AND RADIOISOTOPE REMOVAL

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FISSION PRODUCT, POISON, AND RADIOISOTOPE REMOVAL 2.00

ADSORPTION 2.01

20006

PROCESS FOR EFFECTING A SELF-SUSTAINING NUCLEAR FISSION REACTION BY MEANS OF NEUTRONS. (to Stichting Reactor Centrum Nederland (Netherlands)). British Patent 804,787. Nuclear Eng. 4, 324(1959) July-Aug.-Sept.

This patent refers to the processing of fuels in a circulating liquid suspension. Fission products are removed from the fuel suspension by adding solid particles of low neutron-absorption capacity, which in the suspension will adsorb fission products liberated into the carrier liquid. These solid particles are added in such quantities that they have collectively an adsorption capacity considerably greater than that of the fissile particles in the suspension. The particles are continuously or periodically separated from the suspension and the removed particles replaced by further adsorbing particles. Owing to the high specific gravity of the fissile material (uranium oxide; thorium oxide) separation is conveniently effected by conducting at least part of the circulating suspension through a secondary circuit and a hydrocyclone which separates the suspension into two fractions. The fission products are separated in a filter and the carrier liquid free from solid matter returned to the suspension circuit. Carbon particles are preferred for adsorbing the fission products.

ON THE ADSORPTION OF SOME FISSION PRODUCTS ON VARIOUS SURFACES. J. Belloni, M. Haissinsky, and Halim N. Salama (Laboratorie Curie, Paris). J. Phys. Chem. 63, 881-7(1959) June.

The adsorption of promethium and tagged cerium and ruthenium from aqueous acid solutions has been studied on various surfaces. Certain apparently anomalous effects in the kinetics of the adsorption processes have been observed and interpreted. The quantities adsorbed at equilibrium increased with pH and, in most cases, passed through a maximum. The lanthanides obey the Langmuir isotherm, whereas the adsorption of ruthenium follows Henry's law. No temperature effect was observed on the adsorption of the lanthanides; the adsorption of ruthenium increases with temperature and is partly irreversible, whereas the adsorption of cerium and promethium is reversible. Possible mechanisms for these processes are discussed in the light of these results and those of other workers. (auth)

13329 BNL-542

Brookhaven National Lab., Upton, N. Y.

THE RECOVERY OF FISSION PRODUCT XENON AND KRYPTON BY ABSORPTION PROCESSES. Meyer Steinberg. Jan. 1959. 18p. $0.75(OTS).

Highly concentrated fission product xenon and krypton can be economically produced with high rates of recovery from diluted nuclear off-gas streams by means of a continuous selective solvent absorption process. The process involves a three-column absorption-fractionation-stripping operation. The absorber removes xenon and krypton along with part of the diluent gases, nitrogen and oxygen; the fractionator removes the nitrogen and oxygen from the solvent; and the stripper produces the highly concentrated noble gas product. Solvent flow rates and stripping gas requirements are considerably reduced by operating the absorber under higher pressure, and the fractionator and stripper at lower pressures. Experimental data on the solubilities of xenon, krypton, nitrogen, oxygen, and argon in liquid nitrous oxide and Freon, measured over a range of temperatures, are presented. The selectivity and solubility of xenon and krypton in these solvents at temperatures of the order of −70°C are significantly higher than in solvents at ambient temperatures. Based on these and earlier solubility measurements, process designs, flow sheets, and column design data are given for each of three solvent systems: kerosene, liquid nitrous oxide, and liquid Freon. The kerosene−carbon dioxide stripping process has the advantages of operation at ambient temperatures and elimination of all heat exchange equipment; however, the cost of carbon dioxide is an economic factor in this case. In the liquid nitrous oxide process, the necessity for a nitrous oxide removal operation is eliminated, but the hazard of using a thermodynamically unstable solvent must be taken into consideration. The Freon process has the lowest refrigeration requirements, a low solvent cost, and maximum stability. The use of solvents having boiling points higher than those of xenon and krypton has the advantages of reducing equipment freeze-up, shielding requirements, and accumulation of hazardous materials in the process. (auth)

15133

ADSORPTION METHOD FOR SEPARATING METAL CATIONS. J. X. Khym (to U. S. Atomic Energy Commission). U. S. Patent 2,877,094. Mar. 10, 1959.

The chromatographic separation of fission product cations is discussed. By use of this method a mixture of metal cations containing Zr, Cb, Ce, Y, Ba, and Sr may be separated from one another. Mentioned as preferred exchange adsorbents are resins containing free sulfonic acid groups. Various eluants, such as tartaric acid, HCl, and citric acid, used at various acidities, are employed to effect the selective elution and separation of the various fission product cations.

RECOVERY OF FISSION PRODUCT NOBLE GASES. Meyer Steinberg and Bernard Manowitz (Brookhaven National Lab., Upton, N. Y.). Ind. Eng. Chem. 51, 47-50(1959) Jan.

An advantage of using an absorption-stripping system over charcoal adsorption is that the noble gas can be removed almost completely in a continuous operation at ambient temperatures. A difficulty with the Amsco absorption-stripping method is that relatively large volumes of organic have to be handled when operating at atmospheric pressure. The absorption-stripping system could be advantageously used where an inexpensive "head end" or primary bulk separation of gaseous activity is required, either for storage until safe disposal to the atmosphere is allowable, or for further processing for complete enrichment or purification of xenon and krypton. Other possibilities include the processing of homogeneous reactor purge gas streams, where a suitable carrier gas, such as helium, can be chosen to allow an increased single-stage concentration factor. This could also be used in processing gas streams from pyrometallurgical processing plants, where there is freedom in the choice of a vehicle gas in purging the gaseous fission products. (auth)

5264 NP-tr-37

THE ENERGY OF ADSORPTION FORCES AND HEAT OF ADSORPTION OF SIMPLE MOLECULES ON GRAPHITE. N. N. Avgul' and A. V. Kiselev. Translated by V. Beak from Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, 230-2(1957). 7p.

This paper was previously abstracted from the original language and appears in Nuclear Science Abstracts, Vol. 11, as abstract No. 7959.

3488 CF-52-2-164

Oak Ridge National Lab., Tenn.

ADSORPTION OF FISSION PRODUCTS ON STAINLESS STEEL IN IAW SOLUTION AND SUBSEQUENT DESORPTION. Quarterly Report for Period November 10, 1951 – February 10, 1952. M. R. Bennett. Feb. 18, 1952. Decl. Dec. 15, 1955. $1.80(ph OTS); $1.80(mf OTS).

The adsorption equilibrium on stainless surfaces for all fission products other than niobium was established within six hr with a specific adsorption activity of approximately 7.0×10^4 c/m/in.^{2} gross β^-. Approximately 75% of the total β activity adsorbed within the first 12 hr was due to Zr-Nb; 15% was due to TRE, and 6% was due to Ru, Cs, and Zr. The adsorption equilibrium for fission products on Type 347 stainless steel appears to be slightly higher than for Type 309, by a factor of 1.05 to 1.08. Results are tabulated. (auth)

6485 A/CONF.15/P/2096

KINETICS OF ADSORPTION OF A MIXTURE OF RADIOISOTOPES ON SURFACES. Z. Dlouhý and J. Malý (Czechoslovakia). 20p.

The theoretical relations are given for the kinetics of adsorption of a radioisotope mixture from solution on a solid surface. The time dependence of the amount of isotope A adsorbed can be described by a function containing two exponentials in the form $A = K_0 - e^{-K_1 t} - e^{-K_2 t}$. The adsorption of Zn^{65}, Po^{210}, and Ca^{45} on stainless steel was studied. (W.D.M.)

16309 AERE-C/R-2632

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

KRYPTON AND XENON ADSORPTION ISOTHERMS ON CHARCOAL IRRADIATED WITH 1 MeV ELECTRONS. C. B. Amphlett and B. F. Greenfield. July 1958. 8p.

Krypton and xenon isotherms on charcoal were measured before and after irradiation with high doses of fast electrons. No reduction in uptake could be detected for doses up to 4×10^{11} rads (1350 watt-hr/g). (auth)

13848

SORPTION OF RADIOACTIVE ISOTOPES BY ALUMINUM HYDROXIDE. S. A. Voznesenskii, V. V. Pushkarev, and V. F. Bagretsov. Zhur. Neorg. Khim. 3, 235-9(1958). (In Russian)

The sorption of Cs^{137}, Sr^{89}, Sr^{90}, Ce^{144}, and Ru^{106} on aluminum hydroxide was studied. The sorption of Sr, Ce, and Ru reached a maximum which was determined by the pH value: 7.0 for Ru, 7.5 for Ce, and 9.0 for Sr. Cs was not adsorbed under all test conditions. Ru and Ce were adsorbed with a positive charge, and Sr with a negative charge. (J.S.R.)

80

MOLECULAR SIEVES ADSORB IODINE-131 FROM AIR. Morris A. Wahlgren and W. Wayne Meinke (Univ. of Michigan, Ann Arbor). Nucleonics 15, No. 9, 156, 158, 160(1957) Sept.

11129 CF-57-6-119

Oak Ridge National Lab., Tenn.

TESTING OF ADSORPTIVE CAPACITY OF CHARCOAL BEDS. HRT Test No. II-A 10 b. R. Van Winkle and R. R. Wiethaup. June 4, 1957. 7p. Contract [W-7405-eng-26]. $1.80(ph OTS); $1.80(mf OTS).

Tests were made to determine the effects of wetting upon the adsorptive properties of fresh charcoal in the laboratory and the HRT charcoal beds in situ. (auth)

6489 NAA-SR-Memo-1874

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

GRAPHITE OUTGASSING. R. Carter, H. Taketani, and D. Wilcox. Mar. 15, 1957. 26p. $4.80(ph OTS); $2.70 (mf OTS).

Empirical test procedures called for the evacuation of the system containing the graphite to a vacuum of approximately 1 μ for 8 hr to remove all the gases that could be removed by exposing the graphite to a vacuum. Due to the large number of runs that had to be made, an 8-hr pump-down time was impractical. Hence, the system was pumped to 4 μ using a 20 min pump-down time, the valve leading to the vacuum pump was shut off, and the pressure rise in the system was observed. At room temperature the background pressure rise as a function of time is illustrated. This pressure rise was subtracted from the total pressure rise resulting from the heating of the graphite for a given time. (auth)

6349

SEPARATION OF ZIRCONIUM AND HAFNIUM USING ANION-EXCHANGE RESINS. PART III. RESOLUTION OF HAFNIA CONCENTRATES. K. S. Rajan and J. Gupta (National Chemical Lab., Poona, India). J. Sci. Ind. Research (India) 18B, 460-3(1959) Nov.

The anion-exchange method of separating hafnium from zirconium previously reported for resolving a naturally occurring mixture (Hf/Zr, 3%) was modified and applied to hafnia concentrates. A complete separation of the two constituents was achieved on a sulfate exchanger by elution with dilute sulfuric acid. About 50% of the eluting acid (pre-breakthrough volume) can be recycled. Gram loads of hafnia concentrates were found to give 93 to 95% recovery of pure hafnia (Zr/Hf, < 0.1%) on 1.5 × 120 cm resin columns. (auth)

6372

RARE EARTH-ACTINIDE SEPARATION BY ADSORPTION. C. S. Lowe and W. H. McVey (to U. S. Atomic Energy Commission). U. S. Patent 2,903,333. Sept. 8, 1959.

Separation of Zr and Nb from aqueous solution by adsorption on glass beads is described. Borosilicate glass is used which is substantially free of Mg, Ca, and Zn.

5084 CEA-tr-R-193

MECANISME ACIDO-BASIQUE D'ADSORPTION SUR SILICAGEL. (Acid-Base Mechanism of Adsorption on Silica Gel). A. V. Kiselev (Kisselev). Translated into French from Doklady Akad. Nauk S.S.S.R. 106, 1046-9 (1956). 10p.

The physical nature of adsorption on silica gel is discussed, and a chemical acid–base mechanism is proposed. (T.R.H.)

ALUMINUM 2.02

See also, under FISSIONABLE MATERIAL--RECOVERY, AL-U FUELS (3.01.01);

and,

under WASTE TREATMENT AND DISPOSAL, RECOVERY OR REMOVAL OF MATERIALS--Al-Containing Wastes (8.05.01).

THE REMOVAL OF FISSION PRODUCTS FROM AN ACID ALUMINUM NITRATE SOLUTION BY CO-PRECIPITATION METHODS. Herman L. Krieger, Bernd Kahn, and Conrad P. Straub. Oct. 20, 1955. 19p. (ORNL-1966)

The removal of the major long-lived fission products by co-precipitation from an acid $Al(NO_3)_3$ solution has been studied. Of the methods investigated the most efficient and economical treatment was found to be the co-precipitation of Ru and Cs with $Cu_2Fe(CN)_6 \cdot xH_2O$; of Sr with $BaSO_4$; of Zr and Nb with $ZrO_3(PO_4)_2$; and of the rare earths and Y with $Ce_2(C_2O_4)_3 \cdot 9H_2O$. Approximately 95% of the added tracers and carriers were removed from solution in a precipitate of about 50 g/l at a cost of $0.015/l.

6537

SEPARATION OF ALUMINUM AND ZIRCONIUM BY THE METHOD OF ION-EXCHANGE. Yu. I. Usatenko and L. I. Gureyeva. Zavodskaya Lab. 22, No. 7, 781-3(1956). (Translated from Referat. Zhur. Khim. No. 4, 1957, Abstract No. 12056).

The method is based on the fact that Zr is absorbed by the cathionite from more acidic solutions than Al. Greatest absorption power is exhibited by the cathionite KU-1 (maximum acidity 1.5 N); next best is cathionite SBSR (1.25 N); least absorption is shown by Wofatit R (0.75 N). Greatest difference in acidity for the absorption of Zr and Al is observed in the case of sulfonated coal, cathionite KU-1 and MOF-1. Al^{3+} ions are not absorbed by sulfonated coal from a 1 N, and by cathionite KU-1 from a 1.5 N, solution of the acid. Best results are obtained using sulfonated coal. The mixture of solutions of Al and Zr is passed through a column containing the cathionite at a rate of 5 ml/minute. Al is determined in the filtrate. Zr is leached out of the column with hydrochloric acid (1:4).

ANTIMONY 2.03

22058

THE CARRIER-FREE PRODUCTION OF Sb^{125} AND In^{113m}. V. N. Rybakov and I. I. Stronskii. Atomnaya Energ. 6, 208-10(1959) Feb. (In Russian)

An ion exchange method was developed for separating antimony and indium from radioactive tin isotopes. The method permits carrier-free production of Sb^{125} and In^{113m}. (R.V.J.)

ENRICHMENT OF RADIOACTIVE ANTIMONY ISOTOPES WITH THE AID OF TRIPHENYLANTIMONY DIFLUORIDE BY THE ATOMIC RECOIL METHOD. V. D. Nefedov and L. N. Evtikheev (Leningrad State Univ.). Zhur. Fiz. Khim. 30, 2090-2(1956) Sept. (In Russian)

A method has been developed for the enrichment of Sb^{122} by using $Sb(C_6H_5)_3F_2$ as the initial compound. The method permitted an enrichment factor of $\sim 10^5$ with yield of ~40 to 45%. Preliminary studies were made on the forms of radioactive antimony in preparation bombarded by slow neutrons. (tr-auth)

BARIUM 2.04

See also, under PROCESS CHEMISTRY AND ENGINEERING, SPECIAL PROCESSES--RaLa (6.17.18).

2498

BARIUM RECOVERY PROCESS. R. E. Blanco (to U. S. Atomic Energy Commission). U. S. Patent 2,895,798. July 21, 1959.

A method of separating barium from nuclear fission products is described. In accordance with the invention, barium may be recovered from an acidic solution of neutron-irradiated fissionable material by carrying the barium out of solution as a sulfate with lead as a carrier and then dissolving the barium-containing precipitate in an aqueous solution of an aliphatic diamine chelating reagent. The barium values together with certain other metallic values present in the diamine solution are then absorbed onto a cation exchange resin and the barium is selectively eluted from the resin bed with concentrated nitric acid.

BARIUM 2.04

19872

SORPTION METHODS OF SEPARATING BARIUM FROM RADIUM, ALUMINUM FROM GALLIUM, AND ZIRCONIUM FROM HAFNIUM. B. N. Laskorin, V. S. Ulyanov, R. A. Sviridova, A. M. Arzhatkin, and A. I. Yuzhin. Atomnaya Energ. 7, 110-16(1959) Aug. (In Russian)

An effective chromatographic separation method was achieved by using complex-forming substances capable of reducing the active concentration forces in ions subjected to separation. In the first approximation such separation amounts to reduction of the number of elements. The difference in complex-forming constants increases the separation coefficient. Optimum conditions were found, using various complex-forming elements, for separating barium and radium, zirconium and hafnium, and aluminum and gallium. The efficiency of the methods is 15 to 60 kg/hr per m^2 of the scale. (tr-auth)

22050

ION-EXCHANGE METHOD FOR SEPARATING RADIUM FROM RADIUM–BARIUM MIXTURES. M. E. Fuentevilla (to U. S. Atomic Energy Commission). U. S. Patent 2,892,679. June 30, 1959.

An improved process is presented for separating radium from an aqueous feed solution containing radium and barium values and a complexing agent for these metals. In this process a feed solution containing radium and barium ions and a complexing agent for said ions is cycled through an exchange zone in resins. The radium-enriched resin is then stripped of radium values to form a regeneration liquid, a portion of which is collected as an enriched product, the remaining portion being recycled to the exchange zone to further enrich the ion exchange resin in radium.

SEPARATION OF RADIUM AND BARIUM BY ION EXCHANGE ELUTION. W. H. Power, H. W. Kirby, W. C. McCluggage, G. D. Nelson, and J. H. Payne, Jr. (Mound Lab., Miamisburg, Ohio). Anal. Chem. 31, 1077-9(1959) June.

Radium can be separated from barium–radium mixtures in ratios as high as 4440 to 1 by a single elution from a cation exchange resin. Barium elution characteristics from Dowex 50 resin, position of elution maxima, and maximum barium loadings are correlated with citrate concentration and pH by the use of citrate complex equilibria. Ammonium citrate, 0.32M at pH 5.6, is the most satisfactory eluent of those used from the standpoints of separation factor and freedom from precipitation in the column. Conditions affecting the precipitation of slightly soluble barium citrate during elution with ammonium citrate are discussed. Eluting above 25°C decreases separation factors and permissible barium levels. (auth)

SEPARATION OF BARIUM VALUES FROM URANYL NITRATE SOLUTIONS. Edward R. Tompkins (to U. S. Atomic Energy Commission). U. S. Patent 2,875,024. Feb. 24, 1959.

The separation of radioactive barium values from a uranyl nitrate solution of neutron-irradiated uranium is described. The 10 to 20% uranyl nitrate solution is passed through a first column of a cation exchange resin under conditions favoring the adsorption of barium and certain other cations. The loaded resin is first washed with dilute sulfuric acid to remove a portion of the other cations, and then wash with a citric acid solution at pH of 5 to 7 to recover the barium along with a lesser amount of the other cations. The pH of the resulting eluate is adjusted to about 2.3 to 3.5 and diluted prior to passing through a smaller second column of exchange resin. The loaded resin is first washed with a citric acid solution at a pH of 3 to elute undesired cations and then with citric acid solution at a pH of 6 to elute the barium, which is substantially free of undesired cations.

BARIUM 2.04

16030 IDO-14445
Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.
LABORATORY DEVELOPMENT OF A PROCESS FOR SEPARATING BARIUM-140 FROM MTR FUEL. E. L. Anderson, R. S. MacCormack, and C. M. Slansky. Mar. 27, 1959. 108p. Contract AT(10-1)-205. $2.50 (OTS).

The results of all laboratory research and development on the process for separation of barium-140 from MTR fuel elements are presented. The steps include caustic dissolution, separation of barium and strontium with fuming nitric acid and removal of strontium by the chromate-acetate method. The results of laboratory and pilot plant corrosion investigations and high radiation level flowsheet tests in the Multicurie Cell are also included. (auth)

6527
BATCH PROCESSING FOR KILOCURIE PRODUCTION OF BARIUM-140. A. L. Ayers and B. M. Legler (Phillips Petroleum Co., Idaho Falls, Idaho). Chem. Eng. Progr. 54, No. 2, 83-6(1958) Feb.

A new batch processing facility recovers kilocurie quantities of Ba^{140} from short-cooled MTR fuel. The process is based on the solubility characteristics of barium and barium salts in selected basic and acidic media. Several of the techniques used are probably applicable to other radiochemical recovery operations. A significant feature of the process is its unique ability to handle short-cooled fuels. (auth)

1298
EVALUATION OF RADIOCHEMICAL SEPARATION PROCEDURES. Duane N. Sunderman and W. Wayne Meinke (Univ. of Michigan, Ann Arbor). Anal. Chem. 29, 1578-89 (1957) Nov.

Radiochemical separation procedures for Ba, Sr, Ca, and Ag are evaluated. Conditions for optimum radiochemical separation of these three alkaline earths and procedures for systematic separation in tracer solutions are given. Two standard and two new methods for separation of radioactive silver are studied. Effectiveness of ferric and lanthanum hydroxides as scavengers on radioactive tracers is also evaluated. (auth)

2822 IDO-14414
Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.
STARTUP OPERATION OF PRODUCTION FACILITY FOR SEPARATING BARIUM-140 FROM MTR FUEL. B. M. Legler, S. F. Fairbourne, P. N. Kelly, and R. A. Robinson. Sept. 1, 1957. 217p. Contract AT(10-1)-205. $5.50(OTS).

Described is the startup operation of a batch production facility for separating and purifying Ba^{140} from short-cooled MTR fuel. Extensive operation involving unirradiated material and low activity level material was conducted prior to high activity level operation. The heart of processing equipment is a special suspended type, batch, solid basket centrifuge which is used for liquid-solid separation. The process is based on the solubility characteristics of Ba and Ba salts in selected basic and acidic media. Startup operation demonstrated adequacy of the flowsheet under irradiation in plant equipment. Recovery of 25,000-c batches of Ba^{140} was shown to be possible with adequate reproducibility at an approximate cost of $3.00 per c. Operating time per batch is 30 hours. The problem of I removal from process off-gas remains unsolved because inadequate provision was made for I removal in the original facility. (auth)

ISOTOPE MILKER SUPPLIES Ba^{137} FROM PARENT Cs^{137} R. L. Newacheck, L. J. Beaufait, Jr., and E. E. Anderson (Tracerlab, Richmond, Calif.). Nucleonics 15, No. 5, 122-5(1957) May.

A device for supplying a convenient source of short-lived isotopes such as Ba^{137} from Cs^{137} is described. It uses ion-exchange separation and an automatic mechanical injection system to supply repeated amounts of a short-lived gamma emitter from a long-lived parent. (T.R.H.)

1887 LA-2037
Los Alamos Scientific Lab., N. Mex.
PROCESS DEVELOPMENT STUDIES FOR RECOVERING Ba^{140} FROM IRRADIATED ENRICHED-URANIUM RODS. John W. Schulte. Mar. 1956. Decl. Apr. 2, 1957. 14p. Contract W-7405-eng-36. $0.20(OTS).

A chemical process using precipitation and filtration techniques was developed to separate Ba^{140} and other fission products from irradiated enriched uranium-stainless steel fuel pins. (auth)

BARIUM 2.04

5282 AECU-3159
Michigan. Univ., Ann Arbor.
THE DEVELOPMENT AND EVALUATION OF RADIOCHEMICAL SEPARATION PROCEDURES FOR BARIUM, CALCIUM, STRONTIUM, SILVER, AND INDIUM. Duane N. Sunderman. Feb. 22, 1956. 213p. Contract AT(11-1)-70, Project 7. $1.00(OTS).

The objective of this research was to conduct a program of development and critical evaluation of radiochemical separation procedures. Procedures for individual elements reported in the literature were collected and subdivided into individual separation steps. Those steps which were found to be unique and to possess general applicability were studied experimentally to determine optimum conditions (of both yield and decontamination) for separation. These steps were then further evaluated under optimum conditions to determine the effects on the separation of a number of diverse but representative elements and materials. (auth)

9625 IDO-14344(Del.)
Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.
PILOT PLANT DEVELOPMENT OF A PROCESS FOR SEPARATING BARIUM-140 FROM MTR FUEL. B. M. Legler, W. L. Chase, M. D. Martin, D. M. Paige, and F. K. Wrigley. Sept. 1, 1955. Decl. with deletions Feb. 11, 1957. 169p. Contract AT(10-1)-205. $25.80(ph OTS); $7.80(mf OTS).

Extensive full-scale pilot plant studies, using unirradiated materials, of a precipitation process designed to separate 30,000 to 50,000 curie quantities of high purity Ba^{140} from a twenty-day-irradiated, two-day-cooled MTR fuel assembly were conducted. Centrifugation was employed to effect liquid-solid separations. This process consists generally of fuel dissolution in five molar NaOH followed by centrifugation of dissolver slurry to remove

12400 ORNL-625
Oak Ridge National Lab., Tenn.
LABORATORY DEVELOPMENT OF THE VERSENE PROCESS FOR THE PURIFICATION OF RADIOBARIUM BY ION EXCHANGE. E. Blanco and A. H. Kibbey. July 30, 1951. Decl. Mar. 8, 1957. 37p. Contract W-7405-eng-26. $6.30(ph OTS); $3.00(mf OTS).

This report presents the laboratory development of the Versene and Nickel-Versene ion exchange processes for the purification of radioactive barium. (auth)

12390 MonT-156(Del.)
[Clinton Labs., Oak Ridge, Tenn.]
PROCESS DESIGN REPORT—706-D BUILDING. J. T. Weills. Aug. 1, 1946. Decl. with deletions Feb. 28, 1957. 41p. Contract W-35-058-eng-71. $9.30(ph OTS); $3.60 (mf OTS).

A plant for the production of Ba^{140} was designed to isolate this fission species from ORNL Graphite Reactor metal. A wet-precipitation process was developed concurrent with design and construction based on the specifications that the product, $Ba(NO_3)_2$, be essentially free of ionic and γ-emitting impurities and contain less than 1 g of inert Ba. The assurance of success was based in large measure on the fact that a similar process was being used to make $BaCl_2$ on a temporary basis under research direction. This report covers the process design of the original installation, a description of facilities as of May 1945, and a résumé of glassware installations to make the chloride salt. Barium chloride was chosen after the first nitrate shipment was made because the nitrate was discovered to be unstable, the specifications on ionic impurities were made more stringent, and the chloride is more soluble than the nitrate. (auth)

11733 CN-2196
[Clinton Labs., Oak Ridge, Tenn.]
PREPARATION OF RADIOACTIVE BARIUM-LANTHANUM. Progress Report [for] April 15, 1944 to September 15, 1944. Problem Assignment No. 263-X60C. D. S. Webster. Nov. 14, 1944. Decl. Feb. 15, 1957. 26p. Contract W-7405-eng-39. $4.80(ph OTS); $2.70(mf OTS).

Procedures are described which were used in the preparation of several 140 curie batches of Ba^{140} to produce 100 curies of the hard γ-emitting La^{140} by the $PbSO_4$ precipitation process. Experiences involved in construction and operation of the engineering scale equipment are reported. Flowsheets and drawings of equipment are included. (C.H.)

BERYLLIUM 2.05

See also, under HAZARDS AND PROTECTION,

BERYLLIUM (4.01.02).

9756
ION-EXCHANGE SEPARATION OF BERYLLIUM BY ELUTION WITH SALICYLATE ANALOGS. Jack Schubert, Arthur Lindenbaum, and William Westfall (Argonne National Lab., Lemont, Ill.). J. Phys. Chem. 62, 390-4(1958) Apr.

Rapid quantitative separations of trace quantities of Be from macro-concentrations of salts including those of Cu, U, and Ca were devised. The method makes use of the fact that Be forms a relatively strong complex with salicylate analogs in the region pH 3 to 4.5 whereas most cations of the alkaline earths do not react significantly with salicylates, and cations such as Cu^2 and UO_2^2 react weakly or not at all in the same pH region. The separation of Be from foreign cations is made by means of a cation-exchange resin. Be is eluted selectively with 0.02 to 0.10M sulfosalicylic acid (SSA) at pH 3.5 to 4.5. Neither Cu^2, UO_2^2 nor Ca^2 are removed under these conditions. Uranyl ion is eluted by SSA at pH 4.5 to 4.7.

14696 A/CONF.15/P/717
Olin Mathieson Chemical Corp., New Haven; Stanford Research Inst., Menlo Park, Calif.; and Sylvania-Corning Nuclear Corp., Bayside, N. Y.
A CONTINUOUS ELECTROLYTIC PROCESS FOR THE PREPARATION OF BERYLLIUM METAL. Robert B. Holden, Milton C. Kells, and Charles I. Whitman. 7p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

The continuous production of beryllium metal by low temperature fuel salt electrolysis into a continuous circulating mercury cathode was demonstrated. The electrolyte employed is a 50-50 mol % $NaCl-BeCl_2$ mixture with a melting point under 300°C. The beryllium which deposits in the mercury forms an amalgam which can be removed continuously from the mercury stream by filtration. The amalgam contains about 2% beryllium by weight and can be vacuum hot-pressed directly to beryllium metal; or, alternatively, beryllium powder can be prepared by the distillation of the mercury. (auth)

METHOD OF PRODUCING METALS FROM THEIR HALIDES. F. H. Spedding, H. A. Wilhelm and W. H. Keller (to U. S. Atomic Energy Commission). U. S. Patent 2,785,065. March 12, 1957.

A method is given for the production of metallic Be from its halides. The method consists in reducing the Be halide, usually BeF_2, by reaction with an alkali metal or alkali earth metal preferably with a mixture of Ca and Mg. An additional feature, is the admixture, with the reaction mass, of some substance such as S, I_2 or an oxidizing salt, capable of an exothermic reaction with the reducing metal. This is done in order to develop a temperature higher than the melting point of the metal being produced. (auth)

200
SEPARATION OF BERYLLIUM FROM ALUMINUM AND OTHER ELEMENTS BY EXTRACTION METHOD. I. P. Alimarin and I. M. Gibalo (Lomonosov Moscow State Univ.). Zhur. Anal. Khim. 11, 389-92(1956) July-Aug. (In Russian)

The extraction of acetylacetonates of Al, Cr, Co, Fe, Ni, Mn, Zn, Cd, Pb, Cu, Ca, and Mg in the presence of the trilon B by organic solvents (carbon tetrachloride, chloroform, n-butanol, and isoallyl alcohol) has been studied. Experiments were made of quantitative extraction of acetylacetonate of Be in the presence of the trilon B and its separation from Al. A rapid and accurate method of separation and determination of Be in bronze has been developed. (tr-auth)

8350 BC-43(Del.)
California. Univ., Berkeley. Radiation Lab.
THE RECOVERY OF C^{14} FROM IRRADIATED BERYLLIUM NITRIDE. B. A. Fries. Mar. 7, 1947. Decl. with deletions Feb. 13, 1957. 11p. Contract W-7405-eng-48. $3.30(ph OTS); $2.40(mf OTS).

Both acid and alkaline dissolutions of Be_3N_2 were carried out. The two methods are discussed and results given. The recommended alkaline dissolution procedure is outlined. (M.H.R.)

BISMUTH 2.06

REMOVAL OF FISSION PRODUCTS FROM URANIUM–BISMUTH FUELS. O. E. Dwyer, A. M. Eshaya, and F. B. Hill. 24p. (A/CONF.15/P/1781)

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

Processing of fuel, consisting of U, Mg, and Zr in Bi, for the LMFR is described, and recent experimental results are discussed. The volatile fission products to be removed are Xe and Kr, which are removed by the same methods. Non-volatile fission products include high cross-section rare earths; these can be removed from the fuel by fused chloride melts. Two methods of removal of Zr to minimize corrosion are described. A method is given for removal of fission products whose chlorides are less stable than $BiCl_3$ and those whose chlorides are more stable than $BiCl_3$ but less stable than UCl_3.

SEPARATION OF URANIUM FROM BISMUTH BY ANION EXCHANGE RESINS. Gurupada Banerjee and Arno H. A. Heyn (Boston Univ., Mass.). Anal. Chem. 30, 1795-7(1958) Nov.

A method for the ready separation of trace amounts of uranium from large excess of bismuth allows for subsequent determination of uranium. At pH between 1.0 and 1.5 the sulfate complex of uranium(VI) is quantitatively retained by a quaternary amine-type anion exchange resin while the cationic bismuth ion passes through the column. Uranium can then be eluted for analysis by dilute perchloric acid. The method can be used for the separation of microgram quantities of uranium from bismuth, permitting the routine determination of uranium. (auth)

5820

SEPARATION OF BISMUTH FROM URANIUM USING THIOACETAMIDE PRECIPITATION. G. A. Stoner and H. L. Finston (Brookhaven National Lab., Upton, N. Y.). Anal. Chem. 29, 570-1(1957) April.

This work was initiated to find a suitable means for the removal of Bi from small amounts of U allowing for a subsequent determination of the latter. It was found that bismuth sulfide could be precipitated from a homogeneous solution using thioacetamide with no apparent loss of U. A rapid, quantitative method for the separation of Bi from microgram quantities of U was obtained permitting the routine analysis of U. (auth)

RECENT ADVANCES IN THE CHEMISTRY OF LIQUID METAL FUEL REACTORS. R. H. Wiswall, J. J. Egan, W. S. Ginell, F. T. Miles, and J. R. Powell. 16p. (A/CONF.15/P/1434)

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

Recent research has clarified the reactions which occur when U-Bi reactor fuel is contacted with fused salt for the purpose of removing certain fission products. Both engineering data and information about the basic chemistry of the systems involved have been obtained. The best process salt is believed to be the ternary eutectic $MgCl_2$-NaCl-KCl, m.p. 396°C. With this, the reaction by which fission products are removed is of the form 3 $MgCl_2$ (in eutectic) + 2 Ce (in Bi) → 3 Mb (in Bi) + 2 $CeCl_3$ (in eutectic), Ce being a typical salt-extractable fission product. The equilibrium distribution of elements between liquid metal and salt phases is uniquely related to the electric potential at the salt-metal interface. This potential can therefore be used, in principle, to monitor and control a practical process for decontamination and adjustment of U concentration. An experimental study of the galvanic phenomena encountered in a flowing countercurrent system of liquid metal and electrolyte was undertaken. In the preliminary stages, Hg and aqueous solutions were used instead of Bi and fused salt. Electrokinetic effects were found to be sufficiently large that they affect the emf

199

METHODS OF ISOLATION OF CARRIER-FREE RADIOACTIVE ISOTOPES. PRODUCTION OF RADIOCHEMICALLY PURE ThB AND ThC. N. P. Rudenko (Second Research Inst. of Physics, Moscow State Univ.). Zhur. Anal. Khim. 11, 371-5(1956) July–Aug. (In Russian)

A rapid and simple extraction method for separation of radioisotopes $ThB(Pb^{212})$ and $ThC(Bi^{212})$ has been developed. Radiochemically pure preparations of Pb and Bi radioisotopes, both carrier free and with carrier, were obtained by the newly developed method. (tr-auth)

9640 NAA-SR-Memo-125

North American Aviation, Inc., [Downey, Calif.]

HTR CHEMICAL PROCESSING—BISMUTH TRICHLORIDE AS A DECONTAMINANT FOR BISMUTH. D. Cubicciotti. Dec. 19, 1951. Decl. Feb. 28, 1957. 7p. $1.80(ph OTS); $1.80(mf OTS).

The separation and removal of fission products from liquid Bi by treatment with fused $BiCl_3$ was demonstrated. A one-step process for the fission product decontamination of Bi coolant is suggested. (C.W.H.)

BORON 2.07

See also, under HAZARDS AND PROTECTION, DUSTS AND POWDERS (4.01.03).

9291 HEC-87
Hooker Electrochemical Co., Niagara Falls, N. Y.
QUARTERLY AEC RESEARCH AND DEVELOPMENT REPORT FOR JANUARY, FEBRUARY AND MARCH 1958. George T. Miller. Apr. 17, 1958. 17p. Contract AT(30-1)-1524. $3.30(ph OTS); $2.40(mf OTS).

A new method of separating boron isotopes by exchange between a liquid boron trifluoride complex and a solid boron trifluoride complex was investigated. The results were negative. The effect of additives to the fused salt electrolyte in the cell for the production of elemental boron yielded some unpredicted results. The addition of aluminum fluoride monohydrate improved the crystallinity of the deposit. The addition of elemental aluminum apparently improved the crystallinity, yield and purity of the product. An unpredicted improvement in yield and purity of elemental boron resulted when water was added to the electrolyte. Although sulfates had no apparent effect, nickel, Inconel and vanadium had deleterious effects on yield and

12096
METHOD OF PURIFYING URANIUM. (to U. K. Atomic Energy Authority (U.S.A.)). British Patent 786,883. Nuclear Eng. 3, 272(1958) June.

In some uses of uranium, concentrations of boron over 0.5 ppm are definitely objectionable. Uranium of low boron impurity may be obtained by electrolysis of a bath composed of a halide of uranium fused in a mixture of chlorides held at such a temperature that the metallic uranium is deposited as a coarse powder on a cathode of, e.g., molybdenum. Higher bath temperatures than 900°C would reduce the boron content but cause difficulties owing to excessive corrosion and liquefying of the uranium at the cathode. The removal of further amounts of boron may be effectively accomplished by burning the uranium to form an oxide and then heating the uranium oxide to above 1,000°C (preferably 1,200°C) at which temperature a substantial proportion of the boron impurities is volatilized from the oxide. The purified oxide then may be converted to the nitrate and uranium metal produced electrolytically without further increase in the boron content.

14937
SEPARATION OF BORON ISOTOPES. III. THE n-BUTYL SULFIDE-BF_3 SYSTEM. A. A. Palko (Oak Ridge National Lab., Oak Ridge, Tenn.). J. Chem. Phys. 30, 1187-9(1959) May.

The gas-liquid isotopic exchange between BF_3 and the n-butyl sulfide-BF_3 complex was studied as a possible system for enriching boron isotopes. The single stage separation factor varied from 1.054 at −20°C to 1.033 at 26°C. B^{10} concentrated in the liquid phase. The heat of association of the n-butyl sulfide-boron trifluoride complex was determined to be −12.76 ± 0.06 kcal/mole from a series of vapor pressure measurements of the complex made at several mole ratios of BF_3 to sulfide. (auth)

8362 HEC-86
Hooker Electrochemical Co., Niagara Falls, N. Y.
RECOVERY OF POTASSIUM FLUOBORATE FROM SPENT ELECTROLYTE. George T. Miller. Mar. 31, 1958. 7p. Contract AT(30-1)-1524. $1.80(ph OTS); $1.80(mf OTS).

The electrolytic reduction of elemental boron enriched in the B^{10} resulted in a waste product. The waste product, spent electrolyte, contained potassium fluoride, potassium chloride, and potassium fluoborate. By recrystallization from a hot 25% aqueous solution of the spent electrolyte, > 98% pure potassium fluoborate was reclaimed. The yield was > 70% of theoretical. (auth)

5295
SEPARATION OF BORON ISOTOPES. II. THE BF_3 ANISOLE SYSTEM. A. A. Palko, R. M. Healy, and L. Landau (Oak Ridge National Lab., Tenn.). J. Chem. Phys. 28, 214-17(1958) Feb.

A new gas-liquid countercurrent system has been developed for the separation of boron isotopes. This system utilizes the exchange reaction between BF_3 gas and the BF_3 · methyl phenyl ether (anisole) complex. Quantitative dissociation of the complex is attained by heating, and recombination by cooling. Half-time for the isotopic exchange has been shown to be less than three seconds. The single-stage separation factor [$B^{10}F_3$ · anisole (liq.)/$B^{11}F_3$ · anisole (liq.)/$B^{10}F_3$ (gas)/$B^{11}F_3$ (gas)] varies from 1.039 at 0°C to 1.028 at 30°C. Physical properties of the complex have been determined and solvent decomposition has been studied. (auth)

BORON 2.07

5294

SEPARATION OF BORON ISOTOPES. I. BORON TRIHALIDE ADDITION COMPOUNDS. R. M. Healy and A. A. Palko (Oak Ridge National Lab., Tenn.). J. Chem. Phys. 28, 211-13(1958) Feb.

Isotopic separation factors for several gas–liquid systems for concentrating boron isotopes have been determined. Separation factors at 25°C are:

System	(B^{10}/B^{11}) liq/(B^{10}/B^{11}) gas
BF_3(g) vs anisole • BF_3 (liq.)	1.032 ± 0.011 (95% C.L)
BF_3(g) vs di-n-butyl sulfide • BF_3 (liq.)	1.033 ± 0.005 (95% C.L)
BF_3(g) vs phenol • BF_3 (liq.)	1.027 ± 0.014 (95% C.L)

Separation factors for a number of BCl_3–organic systems have also been studied, and a new compound $(C_6H_5)_2O \cdot BCl_3$ has been prepared and characterized. (auth)

NOTE ON THE FEASIBILITY OF THE BORON FLUORIDE MONOHYDRATE PROCESS OF BORON ISOTOPE SEPARATION. Slobodan V. Ribnikar and Živojin V. Knežević. Bull. Inst. Nuclear Sci. "Boris Kidrich" (Belgrade) 9, 111-13(1959).

The boron isotope separation process, based on the exchange between boron trifluoride and boron trifluoride monohydrate, contains a chemical reflux reaction. Sulfur trioxide is used to convert the monohydrate to boron trifluoride gas. A method is given for limiting the great solubility of boron trifluoride in the sulfuric acid. By this method a reflux ratio of 325 is attainable, sufficient for the production of boron-10 with 99% isotopic purity. (A.C.)

Hooker Electrochemical Co., Niagara Falls, N. Y.
BORON ISOTOPE SEPARATION WITH ANISOLE–BORON TRIFLUORIDE COMPLEX. Kenneth O. Hambrock. Aug. 26, 1957. 38p. Contract AT(30-1)-1524. $6.30(ph OTS); $3.00(mf OTS).

Three aspects of the anisole–BF_3 system for B isotope separation were investigated: metal corrosion in anisole at reflux temperatures in the presence of BF_3, both with and without water, anisole decomposition in the presence of varying water content, and anisole purification methods. An analytical distillation technique for determining anisole decomposition is described. The properties of a new azeo trope, n-dodecane and phenol, are reported. Recommended materials of construction, anisole purity, and decomposition product tolerances are given for design purposes. (auth.)

392

A CHEMICAL METHOD FOR THE SEPARATION OF BORON ISOTOPES. G. M. Panchenkov, V. D. Moiseev, and A. V. Makarov (Lomonosov Moscow State Univ.). Zhur. Fiz. Khim. 31, 1851-60(1957) Aug. (In Russian)

A chemical exchange method has been proposed for separating boron isotopes using BF_3 and a liquid complex compound of BF_3 decomposing at low temperatures. The system of BF_3 and anisole was used, and some of its properties have been investigated. A novel countercurrent arrangement was tested for separating boron isotopes based on the chemical exchange between BF_3 and its anisole complex. The method may be used for production of B^{10}-enriched boron on an industrial scale. (tr-auth)

11534

METHOD OF SEPARATING AND CONCENTRATING ISOTOPES OF BORON AND OXYGEN. R. H. Crist et al. (to U. S. Atomic Energy Commission). U. S. Patent 2,796,330. June 18, 1957.

A method is given for separating in relatively pure form, a desired isotope of an element particularly B^{10} from B^{11}. An effective separation of the boron isotopes may be achieved by forming a complex of BF_3 and a lower aliphatic ether such as dimethyl ether. This complex, which is a liquid that dissociates reversibly in the vapor phase to a substantial extent, is then heated to convert a portion of the liquid into the vapor phase. A countercurrent flow of the liquid and vapor phases is established while maintaining the liquid and vapor phases in intimate contact with one another in a fractionating column. The isotopic species that contains boron of mass 11 tends to move upward in the column and the isotopic species containing boron of mass 10 tends to move downward. Thus, it is possible to concentrate either or both isotopic species of the complex to any desired extent. (auth)

6453 ✓

COMPLEX DISTILLATION SEPARATES ISOTOPES. Chem. Eng. 64, No. 5, 149-50(1957) May.

A distillation process is described using 6 columns with a total height of 350 ft (360 transfer units) and producing boron with a 92 to 93% B^{10} enrichment. Dimethyl ether, produced on the site, is complexed with BF_3 and fed into the distillation unit. The enriched complex is converted to KBF_4 and electrolyzed. Plant output is about 1000 lb. B^{10}/yr. (T.R.H.)

BORON 2.07

5189 HEC-74
Hooker Electrochemical Co., Niagara Falls, N. Y.
QUARTERLY REPORT FOR OCTOBER, NOVEMBER AND DECEMBER 1956. George T. Miller. Dec. 31, 1956. 14p. Contract AT(30-1)-1524. $3.30(ph OTS); $2.40 (mf OTS).

The anisole–BF_3 system for isotope separation was shut down. The dimethyl ether–BF_3 system producing B^{11} on a pilot plant scale has been successfully operated. A study is being conducted on the corrosion of various metals by anisole–BF_3 complex at elevated temperatures. The preparation of KBF_4 enriched in B^{11} was carried out in the laboratory to avoid contamination with B^{10}. (W.L.H.)

11006 WAPD-PWR-CP-2649
[Westinghouse Electric Corp. Bettis Plant, Pittsburgh.]
REMOVAL OF BORIC ACID FOLLOWING CHEMICAL SHUTDOWN OF PWR. C. S. Abrams. [Dec. 1956]. 2p. $1.80(ph OTS); $1.80(mf OTS).

A bench-scale test was run to determine the effectiveness of LiOH resin for removing boric acid following chemical shutdown of the PWR. (J.E.D.)

11577 ORNL-2069
Oak Ridge National Lab., Tenn.
THE ANCO SYSTEM FOR BORON ISOTOPE ENRICHMENT. Progress Report for Period Ending September 20, 1955. R. M. Healy, E. F. Joseph, and A. A. Palko. May 1, 1956. Decl. Mar. 2, 1957. 49p. Contract W-7405-eng-26. $0.45(OTS).

A new gas-liquid countercurrent system (the ANCO system from ANisole-COmplex) for the enrichment of boron isotopes was developed. The system utilizes the exchange reaction between BF_3 (gas) and $BF_3 \cdot$ anisole(liquid) to concentrate B^{10} in the liquid phase. The single stage isotopic separation factor for this system was found to vary from 1.039 at 0°C to 1.029 at 30°C. The isotopic exchange reaction was shown to be rapid. Vapor pressures of the complex as a function of temperature were measured and the heat of formation of the complex determined. Laboratory experiments show that quantitative removal of the BF_3

13596 NYO-1265
Hooker Electrochemical Co., Niagara Falls, N. Y.
ELECTROLYTIC BORON PROCESS. George T. Miller. May 31, 1956. Decl. Apr. 12, 1957. 30p. Contract AT(30-1)-1524. $9.30(ph OTS); $3.60(mf OTS).

A fused salt electrolytic method was developed for the production of elemental crystalline boron in 85% yield with a purity of 95%. An economic comparison with the Hot Wire process indicated a 30% reduction in production cost. (auth)

5424
DETERMINATION OF THE SEPARATION COEFFICIENTS OF THE ISOTOPES OF BORON IN THE EQUILIBRIUM EVAPORATION OF BCl_3. N. N. Sevryugova, O. V. Uvarov, and N. M. Shavoronkov. Soviet J. Atomic Energy 4, 567-72 (1956).

The separation coefficients of the isotopes of boron are determined for equilibrium evaporation of boron chloride in the temperature interval 12.7 to 85°C. The methods are described, and the equation relating the dependence of the coefficient on the vaporization temperature is derived. (auth)

12332 NBL-118
New Brunswick Lab., AEC, N. J.
QUARTERLY PROGRESS FOR THE PERIOD ENDING JUNE 30, 1955. (Classified Section). C. J. Rodden. Sept. 1955. Decl. Mar. 1, 1957. 19p. $0.30(OTS).

Methods of reducing the boron content of synthetic, high-boron, UO_3 feeds, during their processing to UF_4 have been investigated. The boron content, initially present in UO_3 as sodium borate to the extent of 1000 ppm of boron to uranium, was lowered in the laboratory to 0.07 ppm by a 5 hr treatment with hydrogen and BF_3 followed by a 2 hr hydrofluorination to produce UF_4. The reduction step, alone, using 0.025 mol % BF_3 in the gas phase reduced the boron level from 1000 ppm to 5 ppm by what was postulated to be the evolution of boron oxyfluoride. The presence of the same amount of BF_3 in the gas phase during the hydrofluorination, depressed the volatilization of the boron compound from the UO_2. This is consistent with the theory that the boron was evolved as the trifluoride during this treatment. When boron was added as boric acid to the UO_3,

BORON 2.07

13845 M-5507
Girdler Corp. Gas Processes Div. Process Development and Research Labs., Louisville, Ky.
SEPARATION OF THE BORON ISOTOPES BY ATMOSPHERIC DISTILLATION OF DIMETHYL ETHER-BORON TRIFLUORIDE COMPLEX. W. M. Keely and Kenton Atwood. June 3, 1953. Decl. Mar. 6, 1957. 25p. Contract [AT(30-1)-1506]. (T9.40-2-2). $7.80(ph OTS); $3.30(mf OTS).

1891 MCW-230
Mallinckrodt Chemical Works, St. Louis.
A STUDY OF THE REMOVAL OF BORON FROM ETHER SOLUTIONS FOR URANYL NITRATE BY SPRAY WASHING WITH DISTILLED WATER. K. Eckberg. Oct. 28, 1949. ~~Decl. Apr. 8, 1957~~. 10p. $4.80(ph OTS); $2.70 (mf OTS).

CENTRIFUGATION 2.08

See also, under PLANTS AND EQUIPMENT, CENTRIFUGES (5.03).

16546
ISOTOPE SEPARATION. A. Klemm. Atomwirtschaft 3, 341-2(1958) Aug.-Sept. (In German)
Processes developed in the German Federal Republic for the separation of isotopes are described. These include distillation of liquid hydrogen and dual-temperature exchange for the production of heavy water, gas centrifugation and separation nozzle for uranium enrichment, and other methods for the enrichment of magnesium, lithium, and C^{14}. (J.S.R.)

13307
ENRICHMENT OF URANIUM ISOTOPES BY THE GAS CENTRIFUGE PROCESS. W. Groth (Universität Bonn). Nukleonik 1, 68-73(1958) July. (In German)
A survey is presented on the enrichment of uranium isotopes by gas centrifuge processes. Emphasis was placed on the studies performed in Germany since 1941. 27 references. (J.S.R.)

6526
HYDROCLONE CENTRIFUGING REMOVES HOMOGENEOUS REACTOR FISSION PRODUCTS. W. D. Burch (Oak Ridge National Lab., Tenn.). Chem. Eng. Progr. 54, No. 2, 79-82(1958) Feb.
Insoluble corrosion and fission products are shown to be effectively removed by centrifugal separation in a hydraulic cyclone operated at reactor temperature and pressure. These insolubles comprise all corrosion products except nickel and approximately 70% of the fission products. A weekly batch purge of the recovered solids with 2% of the fuel solution keeps in balance the soluble fission and corrosion products. Over 1,000 hours of nonradioactive operation of the hydroclone system have demonstrated operability and established performance characteristics of the system. Data preliminary to radioactive operation, scheduled to begin about January 1, 1958, are reported. (auth)

14698 A/CONF.15/P/723
Virginia. Univ., Charlottesville and Virginia. Univ., Charlottesville. Ordnance Research Lab.
TESTS OF THE THEORY OF ISOTOPE SEPARATION BY CENTRIFUGING. J. W. Beams, L. B. Snoddy, and A. R. Kuhlthau. 20p. $0.50 OTS).
Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.
Several experiments designed to test the theory for the separation of isotopes in a centrifuge are described. The separations were carried out primarily with the process material in the gaseous or vapor phase. Most of the separation experiments were made on the isotopes of chlorine in carbon tetrachloride and ethylchloride. The evaporative-centrifuge method and the concurrent centrifuge method were investigated. In each of the experiments the temperature of the centrifuge rotor was held uniform and constant. (auth)

CENTRIFUGATION 2.08

15118 A/CONF.15/P/2391
Oak Ridge National Lab., Tenn.
AQUEOUS HOMOGENEOUS REACTOR FUEL TECHNOLOGY. 53p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

Development of the technology of uranyl sulfate solutions and thoria slurries for power breeder reactors is outlined. In uranyl sulfate systems phase separations can occur in the temperature range of 250 to 300°C, although additions of sulfuric acid and alkali metal sulfates are effective in suppressing these. Dissolved copper is completely effective in recombining the hydrogen (or deuterium) and oxygen which are produced by the radiolytic decomposition of water in fissioning uranyl sulfate solutions. Alloys considered most as materials of construction for homogeneous reactors are Zircaloy-2, austenitic stainless steels, and commercially pure titanium. Austenitic stainless steels develop a protective anhydrous α Fe_2O_3 film at 250°C and higher temperatures. Stability of the film depends on solution composition, rate of flow and temperature. In the absence of an oxidant such as oxygen, uranyl ion is reduced and a very corrosive solution is formed. Crevices and stagnant regions where oxygen depletion can be encountered must be avoided. The out-of-pile corrosion behavior of stainless steel is relatively unchanged by exposure to a solution in which fission is taking place but where exposure is to solution circulating outside the neutron flux region. Zircaloy-2 is very resistant to attack in non-fissioning solutions. In-pile the corrosion rate increases with increasing power density and temperature. Titanium generally behaves like Zircaloy-2 but the in-pile corrosion rates are lower. Products accumulate in reactor solutions as a result of nuclear and corrosion processes and must be removed. The chemical behavior of some of the products has been investigated as have methods for their removal. Materials like iron, zirconium, barium, and the rare earths form insoluble salts or hydrolysis products which can be removed by filtration or centrifugation methods. Nickel, manganese, and cesium are soluble and are removed by solvent extraction or by separation of the uranium as a peroxide precipitate. Iodine, xenon, and krypton can be removed by stripping the fuel solution with oxygen or steam. Important progress has been made in developing thorium oxide slurry fuels for power breeder reactors. Thoria has been produced with controlled particle size, shape and surface area. The effects of firing temperature in the range of 450 to 1600°C, and the effects of pH and additives such as sulfate and silicate on the thoria properties have been investigated. Slurries have been irradiated at power densities and for times equivalent to those expected in a thorium breeder blanket without important change in properties. Molybdenum oxide is a promising catalyst for recombining radiolytic gas. Heat transfer and fluid flow characteristics in both laminar and turbulent flow can be related to conventional correlations for Newtonian fluids through the non-Newtonian rheologic coefficients. Corrosion and erosion of structural materials are governed by the size and shape of the particles, the concentration and velocity and by the presence of additives. Data are being obtained to show the effects of radiation on corrosion. Thoria slurries have been circulated in engineering equipment for thousands of hours. Corrosion and erosion have been a problem only in the circulating pumps and in very high velocity or turbulence regions in the piping and valves. (auth)

6515 A/CONF.15/P/1121
THE ENRICHMENT OF URANIUM ISOTOPES WITH ULTRACENTRIFUGES. J. Kistemaker, J. Los, and E. J. J. Veldhuyzen (Foundation for Fundamental Research on Matter, Amsterdam). 10p.

The ultracentrifugation of UF_6 offers a promising method for an economical production of enriched U^{235} material. The fundamental theory of centrifuges is discussed, and the consequences with respect to constructional considerations and economical aspects are outlined. Results of chemical corrosion tests on various materials are given in connection with the discussion of the mechanical properties of the materials selected for use. (auth)

CENTRIFUGATION 2.08

5187 AERE-CE/M-24
[Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England].
A PROPOSED LIQUID EXTRACTION DEVICE USING A CENTRIFUGAL FIELD. S. G. Bauer. Mar. 16, 1951. Decl. Dec. 13, 1956. 4p.

7296 A/CONF.15/P/1807
ENRICHMENT OF THE URANIUM ISOTOPES BY THE GAS-CENTRIFUGE METHOD. W. E. Groth, K. Beyerle, E. Nann, and K. H. Welge (Univ. of Bonn). 17p.
The design, operation, and theory underlying the operation of gas centrifuges for the separation of uranium isotopes are described. (J.E.D.)

11488 CF-59-3-62
Oak Ridge National Lab., Tenn.
HRT-CHEMICAL PLANT RUN-17 SUMMARY. O. O. Yarbro. Mar. 6, 1959. 19p. Contract [W-7405-eng-26]. $3.30(ph), $2.40(mf) OTS.
The HRT chemical plant hydroclone loop was operated for 829 hr during reactor run 17 and removed 709 g of corrosion product solids from the reactor fuel stream. The composition of corrosion product solids removed averaged 49% Zr, 22% Fe, and 4% Cr, markedly different from solids removed during run 16 which analyzed 51% Fe, 7% Zr, and 5% Cr. The quantity of solids removed by the chemical plant was equivalent to approximately 19% of the stainless steel and 2.5% of the Zr core corrosion products produced in the reactor during run 17. U removed as a solid phase during this run totaled 200 g. Fission products concentrated by the hydroclone included Ru, Zr, Te, Mo, Ce, Y, and Nd. Less than 2% of the I produced by the reactor was found circulating in the reactor fuel, and there was no concentration in the chemical plant. However, other evidence indicated I is held up approximately one day in the high-pressure system compared with a theoretical holdup of about 2 hr if removed quantitively at the let-down rate. (auth)

CERIUM 2.09

ION-EXCHANGE SEPARATION OF CERIUM AND THORIUM WITH LEAD-EDTA COMPLEX AS ELUTING AGENT. Tomitsugu Taketatsu (Kyushu Univ., Fukuoka). Bull. Chem. Soc. Japan 32, 291-3(1959) Mar.
The separation of cerium and thorium ions was studied with a lead-EDTA complex solution as eluant. The optimum conditions were determined as the following: the concentration of the lead-EDTA solution was 0.015 mole, pH 3.0 and the flow rate 1.0 ~ 1.5 ml/min. Thorium ions were completely eluted with 200 ml of the eluant at the optimum conditions, while no cerium ions were detected in the effluent with 1000 ml of the eluant. Thus the use of a lead-EDTA complex solution as eluant was concluded to be effective for separation of cerium and thorium ions. (auth)

5286 NAA-SR-3090
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
A MECHANISM STUDY OF THE OXIDE-DROSSING OF CERIUM FROM MOLTEN URANIUM WITH URANIUM DIOXIDE. T. Smith. Dec. 15, 1958. 64p. Contract AT-11-1-GEN-8. $1.75(OTS).
The mechanism of the oxide-drossing process for extracting cerium from molten uranium has been investigated; the extraction was studied from the standpoint of reaction kinetics and thermodynamics, by chemical analysis, metallography, and x-ray diffraction techniques. It was concluded from this study that the extraction is controlled by different mechanisms during four consecutive time periods. The extraction is initially controlled by chemical reaction at the uranium–uranium dioxide interface, which is quickly superseded by the slower diffusion of cerium from the bulk uranium to the interface. During these periods a reaction product layer is formed and the reaction becomes controlled by the diffusion of cerium through the film. The reaction finally approaches equilibrium in the fourth time period and the concentration of cerium in the uranium comes to an equilibrium value. The second and third period follows an equation of the form $\log(C_0 - C_1)/(\bar{C}_t - C_1) = kt + 1$. Equations relating the apparent diffusion coefficients with temperature for the second and third reaction periods are $D_2 = 5.4 \times 10^{-3}\, e^{-12,500/RT}$ and $D_3 = 2.2 \times 10^{-4}\, e^{-26,200/RT}$, respectively. (auth)

CERIUM 2.09

22010
A RAPID ION EXCHANGE METHOD FOR SEPARATING LARGE AMOUNTS OF CERIUM. RARE EARTH ELEMENTS WITH THE APPLICATION OF AMMONIUM NITRILE TRIACETATE AS THE ELUENT. L. Wolf and J. Massonne. Chem. Tech. (Berlin) 10, 290-6 (1958). (Translated from Referat. Zhur. Khim. No. 1, 1959, Abstract No. 892.)

The separation of rare earth elements (REE) of the Ce group is accomplished in columns 130 centimeters long and 4 centimeters wide, filled with the cationite Vofatite, KPS-200, which has a particle size of 0.2 to 0.4 millimeters. The columns are first filled with the mentioned cationite in Zn-form and on the layer thus obtained the very same cationite is placed, which previously has adsorbed the mixture to be separated. The eluant is passed at a rate of 0.5 cm/min first through the cationite in the REE-form and then through the cationite in the Zn-form, and the eluate fractions are collected. The eluant is prepared by dissolving 200 grams of diammonium salt of nitrile acetic acid (I) in three liters of water, and adding ammonia until the required pH (7-8) is reached and by diluting the prepared solution with water to ten liters. I is inferior to ethylenediamine tetraacetic acid in respect to the effectiveness of the separation ability, but it can be used in solutions of a greater concentration. From the eluate containing I and REE the latter are precipitated as oxalates, the precipitates are filtered off, calcined to the oxides and are dissolved in 5% HCl for further spectrophotometric investigation.

12433 ISC-1069
Ames Lab., Ames, Iowa.
SEPARATION OF CERIUM FROM OTHER RARE EARTHS BY IGNITION OF THE NITRATES. Russell W. Johnson and Edwin H. Olson. Sept. 1958. 33p. Contract W-7405-eng-82. $1.00(OTS).

Cerium was separated from the light rare earths by ignition of the nitrates whereby the cerous nitrate was decomposed to ceric oxide. Small scale investigations were made using sodium nitrate and magnesium nitrate hexahydrate as fluxes. A cost estimate based on data from the small scale investigations showed the sodium nitrate ignition to be more economical; therefore, bench scale investigations were made using sodium nitrate. With a weight ratio of sodium nitrate to rare earth nitrate hexahydrate of 1:2 and a temperature of approximately 295°C for 12 to 16 hours, a nearly quantitative conversion of cerous nitrate to ceric oxide was obtained. The ceric oxide obtained upon dissolving the soluble sodium nitrate and undecomposed rare earth nitrates and filtering, using Celite filtering aid as a precoat, was found to be quite pure. Indications are that an even purer ceric oxide could possibly be obtained if a lower temperature for a longer length of time had been used. (auth)

13728
EQUILIBRIUM BETWEEN CERIUM AND SULFUR IN LIQUID IRON. F. C. Langenberg (Crucible Steel Co. of America, Pittsburgh) and J. Chipman (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME 212, 290-3(1958) June.

Equilibrium in the reaction CeS (solid or in slag) = Ce(in Fe) + S(in Fe) was studied by melting under a neutral atmosphere in pure CeS, Al_2O_3, and MgO crucibles and adding cerium or sulfur. The results show the strong desulfurizing power of cerium. The product [pct Ce] [pct S] was found to be 1.5×10^{-3} at 1600°C. (auth)

13813
COMPLEX FORMATION OF TETRAVALENT CERIUM WITH ACETATE AND OXALATE IONS. II. RECOVERY OF CERIUM FROM NITRIC ACID. N. S. Vagina (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Zhur. Neorg. Khim. 3, 1366-9(1958) June. (In Russian)

Nitric acid salt solutions of rare earth elements were used for the recovery of cerium complexes with acetate and oxalate ions from a mixed cerium group. Advantages of hydroxides of rare earths in the recovery process are given. The principle factor affecting the complete recovery of cerium is the presence of a high content of cerium in oxide form, which in turn depends upon the method of preliminary oxidation and reduction into solutions. (R.V.J.)

CERIUM 2.09

13811
CERIUM EXTRACTION WITH TRIBUTYL-PHOSPHATE. A. V. Nikolaev, A. A. Sörokina, and A. S. Maslennikova. Zhur. Neorg. Khim. 3, 160-4(1958). (In Russian)
It was shown that the extraction of cerium with TBP is determined by the reduction of cerium and its equilibrium distribution. The presence of other rare earth elements does not affect the extraction. A method for the production of cerium from raw materials is described. About 93 to 98% of the cerium can be obtained by this method with a purity of 98%. (J.S.R.)

19847 CEA-tr-R-695
FORMATION DE COMPLEXES DE CERIUM AVEC LES IONS OXALATE ET ACETATE. II. SEPARATION DU CERIUM A PARTIR D'UNE SOLUTION NITRIQUE. (Formation of Cerium Complexes with Oxalate and Acetate Ions. II. Recovery of Cerium from Nitric Acid.) N. S. Vagina (Vaguina). Translated into French by B. Vinogradoff from Zhur. Neorg. Khim. 3, 1366-9(1958). 10p.
This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 13813.

1299
PREPARATION OF RADIOCHEMICALLY PURE CERIUM BY SOLVENT EXTRACTION. H. W. Kirby (Mound Lab., Miamisburg, Ohio). Anal. Chem. 29, 1599-1601(1957) Nov.
Radiochemically pure Ce can be prepared rapidly and inexpensively from reagent grade cerous nitrate by liquid-liquid extraction with tri-n-butyl phosphate. Ce and Th are extracted into TBP. Ce is stripped from organic phase with 8N HNO_3. Product contains 80% of Ce and less than 2% of original radioactivity. (auth)

4296
SEPARATION AND DETERMINATION OF RADIOCERIUM BY LIQUID-LIQUID EXTRACTION. Gilbert W. Smith and Fletcher L. Moore (Oak Ridge National Lab., Tenn.). Anal. Chem. 29, 448-51(1957) March.
Extraction with 2-thenoyltrifluoroacetone-xylene offers a rapid purification technique for radioactive or inactive Ce^{4+} Fission product Ce can be estimated in carrier-free Ce tracer work. The carrier method offers a fast, safe, and simple determination of radio-cerium with yields of about 80% and precision within 2%. (auth)

9265
SEPARATION OF Ce AND Eu FROM URANIUM BY ORGANIC COPRECIPITANTS. Zoran B. Maksimović. Bull. Inst. Nuclear Sci. "Boris Kidrich" (Belgrade) 7, 49-52 (1957) Mar.
The separation of Ce and Eu from uranium by the method of organic coprecipitation is studied. It is found that Ce and Eu can be quantitatively coprecipitated, with diphenyl-44'-bis[<azo4>-1-oxybenzene-2-sulfonic acid] and methyl, violet in the presence of ammonium carbonate as complexing agent for U. (auth)

CESIUM 2.10

18876 AERE-R-2968
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
ALKALI PHOSPHOTUNGSTATES. PART V. EXTRACTION OF CAESIUM FROM FISSION PRODUCT SOLUTIONS. T. V. Healy and B. L. Davies. June 1959. 11p. $0.25(BIS).
A number of methods for separating cesium from fission product solutions are reported briefly together with their suitability of application to the Butex Process waste concentrates. The separation of cesium phosphotungstate is described in some detail together with methods of further purification. (auth)

16005
RECOVERY OF FISSION PRODUCT CESIUM FROM ACIDIC WASTES. H. H. Van Tuyl and R. L. Moore (General Electric Co., Richland, Wash.). Ind. Eng. Chem. 51, 741-4(1959) June.
Experiments in recovery of Cs from Purex-type processes by precipitation with zinc ferricyanide, zinc cobalticyanide, or nickel ferricyanide are reported. Also, addition of urea to the unconcentrated waste solutions as a nitrite suppressor to prevent oxidation when ferricyanides were used was investigated. It was found that either heating or addition of urea satisfactorily removed nitrite. All three precipitants were found to be usable; however zinc ferricyanide appears to be the best. At least 95% of the cesium can be recovered from concentrated wastes. (J.R.D.)

CESIUM 2.10

10087
CHROMATOGRAPHIC SEPARATION OF Cs^{137} FROM Rb–Cs BY SELECTIVE EXTRACTION ON CELLULOSE. J. Fouarge and G. Duyckaerts (Univ. of Liege, Belgium). Anal. Chim. Acta 14, 527-37(1956) June. (In French)

A search for a good method of separating Rb–Cs in micro quantities by chromatography on cellulose has revealed that only with a phenolic eluant (equilibrated with H_2O or 2N HCl) can a specially good separation be easily obtained. This separation remains quite effective from quantities of a few milligrams to "tracer" amounts, and a selective separation of fission Cs^{137} "carrier free", directly from a nitric solution of irradiated uranium was obtained. (auth)

8301
AN ION-SIEVE REAGENT FOR CAESIUM–ALKALI-METAL SEPARATIONS. R. M. Barrer and D. C. Sammon (Univ. of Aberdeen). J. Chem. Soc., 675-82(1956) Mar.

The use of silver analcite as an ion-sieve reagent for separations of Na, K, and Rb from Cs has been investigated. The removal of Na and K from mixtures with Cs (all as chlorides) occurred quantitatively, and readily at about 100°, according to the equation $MCl + xAgA(s) \rightarrow AgCl(s) + MAg_{(x-1)}A_x(s)$ where A denotes the anionic framework of analcite and M is Na or K. In the removal of Na, no Cs entered the silver analcite and the method is suitable for quantitative analysis. In the K–Cs separation a phase change occurs involving a minor rearrangement of the silver analcite to the potassium analcite (leucite) structure, and a little Cs may be incorporated during this process. The Rb–Cs separation is more difficult and requires the use of methanol (or ethanol) as solvent; again a little Cs may be incorporated during the phase change owing to modification of the silver analcite framework to the rubidium analcite one. Hydrogen-ion exchange was observed when solutions of caesium chloride, tetramethylammonium bromide, or tetraethylammonium iodide were treated with silver analcite: $H_2O + MX + xAgA(s) \rightarrow AgX(s) + HAg_{(x-1)}A_x(s) + MOH$. By using the iodide this exchange was followed up to 60% completion. It can only proceed when the crystal acts as a sieve or semipermeable membrane towards the cations in solution and when the ion displaced is precipitated as an insoluble compound. (auth)

4530 CEA-tr-X67
ETUDE SUR LA SÉPARATION DES PRODUITS DE FISSION. PRÉPARATION DE CÉSIUM RADIOACTIF EXEMPT. D'ENTRAÎNEUR. (Study on the Separation of Fission Products. Preparation of Radioactive Carrier-Free Cesium.) T. Siokawa and M. Yagi. Translated by S. S. Minn from Bunseki Kagaku 5, 220-1 (1956). 8p.

Radioactive Cs is separated from other fission products by coprecipitation, first with ammonium phosphotungstate, then with ammonium chloroplatinate. About 80% yield is obtained. (T.R.H.)

THE REMOVAL OF CESIUM AND STRONTIUM FROM RADIOACTIVE WASTE SOLUTIONS. W. W. Schulz and T. R. McKensie. Nov. 29, 1955. 13p. (HW-40180)

Metal ferro- and ferricyanides are the most efficient Cs scavengers known at the present time. These compounds are extremely efficient in removing radiocesium from aqueous wastes of widely different gross salt composition. The ease of handling ferrocyanide precipitates and their small cost are attractive features for large scale waste treatment or fission product recovery operations. Ferrocyanides cannot be applied to the removal of Cs from highly alkaline wastes since they are ineffective at pH's >10. Solid adsorbents, particularly montmorillonite type clays, have shown some promise as agents for removing Cs from highly alkaline solutions. However, to date, no agent has been found that will remove Cs from these wastes with the efficiency that ferro- and ferricyanides exhibit at pH's below 10. Radiostrontium can be removed from alkaline wastes with a wide variety of compounds. Since many wastes contain metal ions whose hydroxides and phosphates are insoluble, merely neutralizing these wastes effects considerable Sr decontamination. Additional Sr decontamination can be obtained with the further precipitation of insoluble phosphates. In particular, Ca and Sr phosphates are very effective scavengers for radiostrontium. (This report appears in TID-7517 Part I.)

CESIUM 2.10

APPLICATION OF COMPLEXONE III FOR CHROMATOGRAPHIC SEPARATION OF Rb AND Cs. A. P. Smirnov-Averin, G. B. Kostarev, and N. N. Krot. Zhur. Analit. Khim 12, 313-17(1957) May-June. (In Russian)

A review is given of physical and chemical properties of complexone III and its application in chromatographic separation on Rb and Cs. Results show that about 90% separation of pure Rb and 65% of Cs has been achieved.

11122 JENER-49

Joint Establishment for Nuclear Energy Research, Kjeller, Norway.

ISOLATION OF CARRIER-FREE Cs^{137} FROM FISSION PRODUCTS. R. A. Wolschrijn. May 13, 1957. 25p.

A method for isolating carrier-free Cs^{137} from mixed fission product solutions by coprecipitation with ammonium alum is worked out. The radiochemical purity of the end product is found to be very satisfactory. (auth)

DETERMINATION OF RADIOCESIUM BY COMPLEX COBALTICYANIDE PRECIPITATION. J. C. Langford. Apr. 15, 1957. 33p. (HW-49668)

Several quantitative precipitants for radiocesium were investigated to determine their effectiveness in separating radiocesium from other common radiocontaminants in fission product waste solutions. Cobaltous cobalticyanide was found to be most satisfactory because of its stability in strong acid solution and its tendency to not carry other radiocontaminants in a strongly acid solution. A satisfactory radiocesium procedure was developed which gave a decontamination factor $>10^5$ for the γ emitting contaminants, Zr-Nb^{95}, Ru^{106}, Ce^{144}, and Sb^{125}. The recovery of radiocesium is >99%. The only substances found to interfere with quantitative separation in 3N H_2SO_4 were $(NH_4)^{+1}$ at >0.5M concentration and HNO_3 at >1M concentration.

1291 HW-48776 RD

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

FISSION PRODUCT RECOVERY FROM CHEMICAL PROCESSING PLANT WASTE SOLUTIONS. G. B. Barton, J. L. Hepworth, E. D. McClanahan, Jr., R. L. Moore, and H. H. Van Tuyl. Feb. 26, 1957. Decl. July 25, 1957. 25p. Contract [W-31-109-Eng-52]. $4.80(ph OTS); $2.70(mf OTS).

A process is described for the recovery of potentially valuable long-lived fission product activities from the first cycle acidic waste solutions which result from the solvent extraction processing of nuclear reactor fuel elements. The metal ferricyanides and ferrocyanides were extensively investigated as scavenging agents for Cs^{137}, and the effects of process variables are reported. Cesium zinc ferrocyanide was found to be the most effective and is used for purposes of concentration and isolation. Subsequent chemical processing results in either a mixed chloride or pure cesium chloride product suitable for use in high intensity radiation sources. $Cerium^{144}$, rare earth, and Sr^{90} activities are recovered by a series of process steps which depend on co-precipitation on ferric hydroxide and on the solubility behavior of the rare earth oxalates, of cerium(IV) iodate, and of strontium carbonate. (auth)

3237

PRECIPITATION PROCESS. W. E. Clifford et al (to U. S. Atomic Energy Commission). U. S. Patent 2,769,780. Nov. 6, 1956.

A method for removing Cs and Sr from aqueous solutions is given. The method is simple, and merely requires formation of a precipitate of $Ni_2Fe(CN)_6$ or $Co_2Fe(CN)_6$ in the solution by the addition thereto of an alkali ferrocyanide and a water soluble salt of Ni or Co. The precipitate acts as a carrier and removes the Cs and Sr. A set of two precipitation operations, one at pH 8-10 and room temperature to remove Cs and the second at a pH over 10 and elevated temperature to remove Sr is found by the inventors to be the most effective embodiment of this process. (auth)

CESIUM 2.10

16004
ON THE CESIUM REMOVAL BY $MnO(OH)_2$ FROM AQUEOUS SOLUTIONS. T. Gerevini and R. Somigliana (Istituto di Fisica del Politecnico, Milan). Energia nucleare (Milan) 6, 339-44(1959) May.

Cesium adsorption by $MnO(OH)_2$ in a variety of conditions was investigated. The influence of the $MnO(OH)_2$ amount used, the method of precipitation, the pH of the solution, the cesium concentration added, and the interfering ions were tested. The capacity of $MnO(OH)_2$ adsorption and the removal coefficients in different cases were determined. (auth)

SYNTHETIC INORGANIC ION-EXCHANGE MATERIALS. III. THE SEPARATION OF RUBIDIUM AND CAESIUM ON ZIRCONIUM PHOSPHATE. C. B. Amphlett and L. A. McDonald (Atomic Energy Research Establishment, Harwell, Berks, Eng.); and J. S. Burgess and J. C. Maynard (Radiochemical Centre, Amersham, Bucks., Eng.). J. Inorg. & Nuclear Chem. 10, 69-73(1959) Apr.

Rubidium and cesium may be efficiently separated in macro-quantities on columns of zirconium phosphate, at loadings up to 10%, by elution with solutions of ammonium salts or of nitric acid. High yields of pure materials are obtained if the separation is performed at elevated temperatures. The results are compared with those for organic resins and for other inorganic exchangers. (auth)

4119 KLX-10089
Vitro Labs., West Orange, N. J.
FISSION PRODUCT SEPARATIONS STUDY. Final Report for the period September 27, 1956–June 30, 1957. R. A. Keeler and C. J. Anderson. Nov. 29, 1957. 47p. Contract W-7405-eng-36. $7.80(ph OTS); $3.30(mf OTS).

The solubility of $SrSO_4$ as a function of temperature and HNO_3 concentration was studied to evaluate this property as a means of separating Sr from radioactive waste. Coprecipitating tests at low and high temperatures were conducted to determine the effectiveness of Ca, Ba, and Pb in scavenging Sr from acid solutions. Several silicate and phosphate minerals were evaluated for their ability to remove Cs and Sr from fission product waste solution. The possibility of extracting slightly soluble cesium picrates from HNO_3 solution by butyl alcohol was investigated with studies of Cs distribution vs. HNO_3 concentration. (See also KLX-10078.) (T.R.H.)

SORPTION OF RADIOACTIVE ISOTOPES ON PRECIPITATES. I. COPRECIPITATION OF CESIUM ON HYDROXIDE AND POLYURANATE PRECIPITATES. V. Kouřím and J. Krtil (Inst. for Nuclear Physics, Czechoslovak Academy of Sciences, Prague). Collection Czechoslov. Chem. Communs. 24, 1104-10(1959) Apr. (In German)

In the study of the sorption processes on precipitates by ferric hydroxide, aluminum hydroxide, and ammonium polyuranate by radiochemical methods, it was found that cesium adhered to these precipitates at pH 8 to 9 by occlusion, adsorption, and chemisorption. The adsorbed cesium can be eluted from the hydroxide by washing. In the case of aluminum hydroxide, an ammonium salt solution is advantageous because of its stabilizing effect on the precipitate. The cesium retained by chemisorption on polyuranate can also be desorbed with an ammonium salt solution, which replaces the cesium bound to the precipitate. The cesium can be quantitatively isolated from the solution which contains iron, aluminum, and uranium in excess by precipitation of the mixture with ammonia and washing of the precipitate with ammonium nitrate solution. In the solution treated, only the ammonium ion was introduced. (tr-auth)

1314
INDUSTRIAL TREATMENT OF SOLUTIONS OF FISSION PRODUCTS–SEPARATION OF Cs^{137}. Presented at the International Conference on Radioisotopes in Scientific Research, Sept. 9-20, 1957 at Paris. No. UNESCO/NS/RIC/13. C. Fisher and A. Raggenbass. London, Pergamon Press, Ltd., 1957. 9p. (In French)

5293
SEPARATION OF A TRACE AMOUNT OF CESIUM FROM LARGE AMOUNTS OF POTASSIUM OR AMMONIUM BY COPRECIPITATION WITH THALLIUM (I) CHLOROPLATINATE. Noboru Yamagata and Eisaku Tajima (Gunma Univ., Kiriu, Japan). Bull. Chem. Soc. Japan 30, 674-5(1957) Sept.

5222
COPRECIPITATION OF A TRACE AMOUNT OF CESIUM WITH THALLOUS SALTS. Noboru Yamagata, Toshiko Yamagata, and Sadakata Watanabe (Gunma Univ., Kiriu, Japan). Bull. Chem. Soc. Japan 30, 577-80(1957) Sept.

Methods are presented using various thallous salts for the coprecipitation of trace amounts of Cs^{137}. (W.L.H.)

CESIUM 2.10

15144 PDB-130
Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.
EXTRACTION AND PURIFICATION OF CESIUM-137. L. C. Watson and R. J. Evans. Sept. 2, 1954. Changed from OFFICIAL USE ONLY Jan. 14, 1959. 34p. (AECL-714). $1.00(AECL).

Both tracer scale and high level activity experimental work were done to develop a process suitable for plant use in the final purification of cesium-137 obtained from the available fission product solutions. The process developed consists of application of alkaline (pH 13) solution to a Duolite C-3 resin column, elution of sodium with 0.25N HNO_3 and then elution of cesium with 1N HNO_3. Products have been obtained with cesium concentrations of 2 mc/ml and radiochemical purities of 99%. (auth)

6448 A/CONF.15/P/1179
A PILOT UNIT FOR THE SEPARATION OF CESIUM 137. A. Raggenbass, M. Quesney, J. Fradin, and J. Dufrene (Commissariat à l'Énergie Atomique, Paris). 26p.

A facility is described for the separation of cesium-137 from solutions of fission products and the preparation of three sizes of pellets for use in gamma sources. The necessary manipulations have been simplified as much as possible. The chemical method used for the processing of the fission product solutions is described. Schematic sketches and photographs of the equipment and facilities are included. (C.H.)

6486 A/CONF.15/P/2098
ISOLATION OF RADIOCESIUM BY DIPICRYLAMINE PRECIPITATION. V. Kouřím and J. Krtil (Czechoslovakia). 10p.

Cesium can be precipitated as dipicrylaminate from the group of alkalies containing ammonium. Cesium is separated from ammonium by ether extraction, and the dipicrylamine is regenerated by means of acidification. The method is suitable for separating cesium-137 from aged fission products. (C.H.)

2330 HW-15742
Hanford Works, Richland, Wash.
THE SEPARATION OF TRACE AMOUNTS OF RADIOACTIVE Cs FROM MACRO QUANTITIES OF SODIUM AND POTASSIUM SALTS. R. C. Thorburn. Jan. 27, 1950. Decl. Dec. 6, 1955. 10p. [Contract W-31-109-Eng-52]. $1.80(ph OTS); $1.80(mf OTS).

A method for the separation of trace amounts of Cs from macro quantities of Na and K using an ion exchange resin, Dowex 50, has been developed. A 95% recovery of Cs with a reduction of the solid content of 95% was found possible. Curves illustrating the effect of acidity, column length, and flow rate are presented. The Na, H, and ammonium forms of Dowex 50 were investigated; the H form was found to give the best separation. (auth)

CHROMATOGRAPHY 2.11

2473
APPLICATIONS OF ION EXCHANGE CHROMATOGRAPHY IN SEPARATION OF TRANSURANIC AND RADIOACTIVE RARE EARTH ELEMENTS. B. K. Preobrazhenskiĭ. Khim. Nauka i Prom. 4, 521-6(1959). (In Russian)

A short review is given of the ion exchange chromatography method for separating tracer amounts of transuranic and radioactive rare earth elements. (R.V.J.)

15948 NP-7697
Rio de Janeiro. Centro Brasileiro de Pesquisas Físicas.
PAPER CHROMATOGRAPHY OF INORGANIC IONS IN NITRATE MEDIA. I. SCANDIUM, YTTRIUM, ACTINIUM AND THE LANTHANIDES. J. Danon and M. C. Levi. 1959. 5p. (Notas de Física Vol. V, No. 7).

The separation of scandium, yttrium, actinium, and the lanthanides by paper chromatography in lithium nitrate media is described. The investigation was based on the extraction of the rare earths by alcohols from nitrate solutions. (auth)

COMPLEX FORMATION 2.12

See also, under PROCESS CHEMISTRY AND ENGINEERING,

COMPLEX FORMATION (6.05),

ION EXCHANGE--Theory (6.12.04),

SOLVENT EXTRACTION--Surveys and Theory (6.16.06).

639

COMPLEX FORMATION AND INTERDECOMPOSITION IN INTERACTION SYSTEMS OF SODIUM AND POTASSIUM TITANATES AND FLUORIDES. M. L. Sholokhovich. (Rostov-on-Don State Univ.). Zhur. Obshchei Khim. 25, 1900-7(1955) Oct. (In Russian)

Metatitanates of sodium and potassium were obtained. Melting diagrams of the interaction systems $Na_2TiO_3 \cdot K_2TiO_3$ and $Na_2TiO_3 \cdot NaF$ were investigated by visual-polythermal melting methods. Studies established that combinations of sodium titanates and potassium titanates in the ratio of 1:1 melt without decomposition at 906°C. Sodium titanate and sodium fluoride in the combination $3Na_2TiO_3 \cdot 2NaF$ melt without decomposition at 899°C. Boundaries of the crystallization zone inside the components, and combinations of $Na_2TiO_3 \cdot K_2TiO_3$ and $3Na_2TiO_3 \cdot 2NaF$ were established, and four triple non-variant points, of which one had eutectic properties and three transitory ones, were found. (tr-auth)

THE SEPARATION OF RADIOACTIVE ISOTOPES BY COMPLEX FORMATION. N. P. Rudenko. Zhur. Neorg. Khim. 1, No. 5, 1091-1103(1956). (Translated from Referat. Zhur. Khim. No. 3, 1957, abstract no. 7408).

A survey is made of the possibilities for the utilization of complex formation (CF) in the separation of isotopes. A graphic presentation of the data of R.N. Maslova on the influence of pH, composition, and concentration of the solution on the extraction (E) of yttrium oxyquinolinate with chloroform is given. The formation of the extractable complex proceeds by a substitution and an addition reaction. The effect of the various factors is reduced to the shift in the CF reaction. Salting-out action leads to a decrease in the solubility of the extractable complex. CF cannot proceed to any extent during the electrolytic separation of the isotopes without a carrier. The original method of E.V. Pastukhov in which the daughter radioactive element is separated by the electrolysis of the complex-containing solution in an organic solvent is described. In^{113m} is separated from the parent Sn^{113} by the electrolysis of the oxyquinolinate of Sn in CH_3Cl. When a field strength of 3,000 v cm^{-1} is used, 76% of the In^{113m} is deposited on the electrodes, of which amount 96% is deposited on the anode. The deposition of Sn on the electrodes increases with time as a result of the formation of Sn ions by radioactive decomposition. In^{115m} is separated from the parent Cd^{115} by the electrolysis of a saturated solution of $Cd(C_5H_5N)_4(SCH)_2$ in CH_3Cl. When a field strength of 500 v cm^{-1} is used, 60% of the In is deposited on the electrodes; at 2,000 v cm^{-1}, deposition of In is 100%. Most of the In is deposited at the cathode (99.7%), while the Cd (some 5% of the total Cd) is deposited primarily at the anode. In^{115m} can also be separated from Cd by extraction of In oxyquinolinate in chloroform. (auth)

2268 Y-475

Carbide and Carbon Chemicals Corp. Y-12 Plant, Oak Ridge, Tenn.

A STUDY OF ZIRCONIUM COMPLEXING AGENTS. D. A. Lee, J. S. Drury, and R. W. Woodard. Aug. 30, 1949. Decl. Dec. 6, 1955. 12p. Contract W-7405-Eng-26. $3.30(ph OTS); $2.40(mf OTS).

An investigation of eleven organic complexing agents in connection with their action on Zr is reported. Results indicate ammonium thiocyanate to be the most promising of the complexes examined. Discussion of procedure is given. (J.E.D.)

13733

ON THE IMPORTANCE OF COMPLEX COMPOUNDS FOR RADIOCHEMISTRY. A. A. Grinberg. Zhur. Neorg. Khim. 3, 195-203(1958). (In Russian)

A review is presented of the importance of complex compounds in radiochemistry. The state of radioisotopes in solution is discussed, and coprecipitation and complex formation are described. Formation of complexes and extraction processes are reviewed. In the final section, a discussion of desorption is given. 30 references. (J.S.R.)

COMPLEX FORMATION 2.12

ION-EXCHANGE STUDIES OF PHOSPHATES. PART III. COMPLEX FORMATION BETWEEN TERVALENT METALS AND ORTHOPHOSPHORIC ACID. J. A. R. Genge and J. E. Salmon (Battersea Coll. of Tech., London). J. Chem. Soc., 1459-63(1959) Apr.

Equilibrium batch experiments with various tervalent-metal (Al, Fe, Ti, In, Sc, Yb, Er, Nd, and La) forms of a strong cation-exchange resin and orthophosphoric and perchloric acid solutions are used to assess the degree of complex formation. Where possible, comparison is made with conclusions based on the results of pH titrations of the metal chloride solutions with phosphoric acid. With perchloric acid there is little sign of complex formation, but with phosphoric acid there is found a regular variation in the degree of complex formation with the ionic radius (non-hydrated) of the metal. There is an optimum ionic radius for complex formation of approximately 0.7 A, corresponding closely to that of titanium(III) and a gradual decrease at higher or lower radii. An explanation of this is offered in terms of the ease of formation of a four-membered chelate ring, and it is shown that the optimum radius of 0.7 A is that required to give the least strain and the minimum distortion of bond angles. (auth)

COSTS 2.13

See also, under SURVEYS (GENERAL), COSTS (7.02).

COSTS 2.13

14388 HW-57582(Del.)
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
TECHNOLOGY OF NON-PRODUCTION REACTOR FUELS REPROCESSING—BUDGET ACTIVITY. Quarterly Report. V. R. Cooper. Sept. 25, 1958. Decl. with deletions Apr. 2, 1959. 11p. Contract W-31-109-Eng-52. $3.30(ph), $2.40(mf) OTS.

Mechanical processing activities for the period are briefly reviewed. Dejacketing and dissolution studies for the Zirflex Process and Niflex Process are outlined. Redox and TBP solvent extraction studies and packed TBP solvent extraction columns are discussed. Zirflex corrosion studies are reported. Analytical developments are briefly outlined. (For preceding period see HW-56477.) (J.E.D.)

10906 CF-56-4-93
Oak Ridge National Lab., Tenn.
INVENTORY AND PRICE LIST OF ELECTROMAGNETICALLY ENRICHED AND OTHER STABLE ISOTOPES. Apr. 1956. 23p. Contract W-7405-eng-26. $4.80(ph OTS); $2.70(mf OTS).

2035 Y-185(Del.)
Carbide and Carbon Chemicals Corp. Y-12 Plant, Oak Ridge, Tenn.
CHEMICAL SEPARATION OF THE ISOTOPES OF URANIUM. R. W. Woodard, L. P. Twichell, D. A. Lee, P. B. Petretzky, J. S. Drury, R. D. Williams, F. V. Tilson, F. B. Waldrop, and G. H. Clewett. Aug. 1948. Decl. with deletions Mar. 6, 1957. 111p. Contract W-7405-Eng-26. $13.80(ph OTS); $4.80(mf OTS).

The enrichment of the isotopes of uranium has been successfully accomplished using chemical exchange reactions. Two such reactions have been utilized: the first involves a two phase liquid-liquid system in which a chloroform solution of an organic complex of uranium is contacted with an aqueous solution of tetravalent uranium ions, after the system has reached isotopic equilibrium, the phases are separated and the uranium recovered: the second is a single phase system, in water, wherein the separation of uranium is accomplished by an exchange reaction involving the exchange of uranium between U^{+4} and UO_2^{+2} ionic species. The separation effects obtained from

DIFFUSION 2.14

19754 CEA-tr-A-590
NOUVEAU PROCÉDÉ DE SÉPARATION DES ISOTOPES. (New Procedure for the Separation of Isotopes.) F. Schultz-Grunow. Translated into French from Z. angew. Math. u. Phys. 9b, Nos. 5-6, 628-36 (1958). 18p.

The separation of mixtures by the use of thermodiffusion is discussed, and the disadvantages of the process are reviewed. However, the disadvantages of the process can be removed by the use of a rotation disk in a tight enclosure. The powerful laminar circular current that is obtained is to a large extent independent of the dimensions of the apparatus and is completely independent of the temperature differences. The apparatus used in the experimental separation of nitrogen and argon is described. The apparatus has the additional advantage of being usable with liquids as well as gases. The results obtained in the separation of argon–nitrogen mixtures are given. The process can be used for the separation of isotopes. (J.S.R.)

5490
THE SEPARATOR TUBE. XIX. FOR THE SEPARATION OF Br^{79} AND Br^{81}. Klaus Clusius and Hans-Ulrich Hostettler. Z. Naturforsch. 12a, 974-82(1957) Dec. (In German)

The separation of bromine isotopes has been investigated by various methods. The theoretical and experimental conditions under which a separation by thermal diffusion was obtainable were studied. The stable isotopes Br^{79} and Br^{81} have a natural abundance of 50.5% and 49.5%, respectively, so that a total separation factor of 100 would be sufficient to supply each with a purity of 99%. The most convenient compound is HBr. The standardization of the dissociation equilibrium $\frac{1}{2} H_2 + \frac{1}{2} Br_2 \rightleftharpoons HBr + 12.2$ cal means a complicating factor at the hot filament of the separation tube since the gases were decomposed by the operation of the separation tube into H_2 and Br_2. The cal-

5955
CONCERNING THE SEPARATION OF ISOTOPES BY SURFACE DIFFUSION IN POROUS MEDIA. W. G. Trawick and A. S. Berman (Oak Ridge Gaseous Diffusion Plant, Tenn.). J. Chem. Phys. 26, 709-10(1957) March.

7934 SO-3262
Rensselaer Polytechnic Inst., Troy, N. Y.
SUMMARY REPORT ON RESEARCH ON ISOTOPE SEPARATION BY A DISTILLATION-DIFFUSION PROCESS. Paul Harteck and Gene Mannella. June 30, 1957. 73p. Contract AT(30-3)-52. $12.30(ph OTS); $4.50(mf OTS).

An investigation has been carried on to study the feasibility of separating isotopes by a process of distillation-diffusion. The process consists of evaporating molecules of the binary mixture to be separated, diffusing them through a barrier gas of suitable mass, and condensing them at a cold surface. The condensate is delivered back to the evaporating surface, setting up a counterflow. Using an all-glass system, isotopes were separated as part of an organic molecule with a stage efficiency of about 50%. In order to increase the effectiveness of the process, an all-metal apparatus with a rotating separation tube was constructed. The rotation of the tube negated the effects of surface tension and permitted the distance between the evaporating and condensing surfaces to be held to a

2799
SEPARATION OF SOME ISOTOPES BY CONVECTION DIFFUSION. D. Heymann and J. Kistemaker (Laboratorium voor Massaspectrografie, Amsterdam, Netherlands). J. Chem. Phys. 24, 165-6(1956) Jan.

The separation of Ne, A, H_2, O_2 and N_2 isotopes by convection diffusion has been investigated. A brief description of the columns used is included. (C.W.H.)

INTERIM REPORT ON THE SEPARATION OF ISOTOPES BY LIQUID THERMAL DIFFUSION. H. T. Hahn. Oct. 21, 1955. Decl. Feb. 26, 1957. 18p. (HW-39477)

Experiments in the separation of U isotopes by liquid thermal diffusion in $UO_2(NO_3)_2$–TBP complex and in aqueous and molten $UO_2(NO_3)_2$ are described.

7702 A-779
Yale Univ., New Haven. Sloane Physics Lab.
FINAL REPORT ON WORK UNDER O. S. R. D. Contract OEMsr-911. William W. Watson. Aug. 5, 1943. Decl. Feb. 12, 1957. 4p. (100XR-1895). $1.80(ph OTS); $1.80 (mf OTS).

Experiments designed to indicate the feasibility of B^{10} concentration by thermal diffusion using BF_3 are discussed. B^{10} may be concentrated by this method, but with very low efficiency. (D.E.B.)

DIFFUSION 2.14

14101 TID-5229
Naval Research Lab., Washington, D. C.
LIQUID THERMAL DIFFUSION. Philip H. Abelson, Nathan Rosen, and John I. Hoover, eds. Sept. 10, 1946. Decl. Feb. 12, 1957. TISE Issuance date Aug. 1958. 258p. (NRL-0-2982). $4.00(OTS).

A revised and expanded version of NNES-IX-1.

The liquid thermal diffusion method for the separation of isotopes is described. The discussion includes the experimental aspects of the method, description of equipment, and the theoretical aspects of the process as applied to the design, development, and performance criteria. A short history of the liquid thermal diffusion method from 1940 to 1945 is presented along with a survey of relevant literature prior to 1940. The remainder of the report is concerned with theoretical aspects. (J.R.D.)

14103 IGRL-T/CA-73
A PROCESS FOR SEPARATING MIXTURES OF ISOTOPES BY DIFFUSION IN A STREAM OF MERCURY VAPOUR. G. Hertz. Translated by B. Rigby (U.K.A.E.A. Industrial Group, Capenhurst) from Z. Physik 91, 810-15(1934). 8p.

The process for separating mixtures of isotopes is improved by replacing diffusion through a porous wall by diffusion in a stream of mercury vapor. For this purpose a specially constructed diffusion pump was used which had the property of preferentially pumping the faster diffusing component. An apparatus, consisting of twelve such stages, causes a change in the ratio of the isotopes of neon by a factor of ten. (auth)

6483 A/CONF.15/P/2086
ISOTOPE SEPARATION BY DIFFUSION IN A STEAM CURRENT. L. G. Gverdtsiteli, R. Y. Kucherov, and V. K. Tskhakaya (U.S.S.R.). 35p.

Experimental and theoretical investigations were made of the separation of isotopes by diffusion in a stream of auxiliary steam. From an analysis of the results it was concluded that the method can be used for separating the isotopes of a number of gases. The method is recommended for obtaining highly enriched isotopes. (C.H.)

DISTILLATION 2.15

See also, this section,

FLUORINATION AND HYDROFLUORINATION (2.19),

and,

under PROCESS CHEMISTRY AND ENGINEERING,

SPECIAL PROCESSES--DeBoer (6.17.05).

7933 SO-3261
Rensselaer Polytechnic Inst., Troy, N. Y.
PROGRESS REPORT ON RESEARCH ON ISOTOPE SEPARATION BY A DISTILLATION-DIFFUSION PROCESS. Paul Harteck and Gene Mannella. June 30, 1957. 11p. Contract AT(30-3)-52. $3.30(ph OTS); $2.40(mf OTS).

An investigation was carried out to study the feasibility of separating isotopes by a process of distillation-diffusion. The process consists of evaporating molecules of the binary mixture to be separated, diffusing them through a barrier gas of suitable mass, and condensing them at a cold surface. The condensate is delivered back to the evaporating surface, setting up a counterflow. (W.L.H.)

9504 K-1220(Del.)
Oak Ridge Gaseous Diffusion Plant, Tenn.
SEPARATION OF LITHIUM ISOTOPES BY MOLECULAR DISTILLATION: SECOND MEVAC PILOT PLANT. J. J. Keyes, Jr., G. A. Kuipers, and D. B. Trauger. June 1, 1955. Decl. with deletions Jan. 15, 1957. 49p. Contract W-7405-eng-26. $7.80(ph), $3.30(mf) OTS.

An improved eight stage molecular still for separating isotopes of lithium is described. This unit incorporates desirable design characteristics of a previous unit, Mevac I, such as, close spacing between distilland and condenser, with a simple stage arrangement permitting gravity flow of distilland. Its special features include a flat condenser surface, improved side and end closures, and elevated distillate flow troughs. Performance of the unit was generally satisfactory, with separation efficiencies at total reflux ranging from 47 to 58%. Stage separation factors varied from 1.052 to 1.064 in the temperature range 627 to 535°C. (Measured distillation rates 0.69 to 0.17 g/(cm^2)(hr)). Corrosion of type 321 stainless steel used in fabrication of the unit was not found to be a serious problem. Certain mechanical limitations resulting in excessive stress concentration in the longitudinal weld seams are recognized, however, and suggestions for a modified design are included. (auth)

DISTILLATION 2.15

10561
ENRICHMENT OF A JET OF VAPOR ENTERING A VACUUM. V. D. Burlakov. Atomnaya Energiya 3, 257-9(1957).

It is known that in the purification of metals by vacuum distillation, the condensate is enriched by oxygen and nitrogen residual gas. The amount of enrichment was measured with a new apparatus. Mercury was vaporized and Hg^{203} vapor was used as the residual gas. The surface of the condensate was covered with a layer of the residual gas, confirming the theory of gaseous enrichment. (J.S.R.)

7476 CF-54-4-176
Oak Ridge National Lab., Tenn.
DISTILLATION COLUMN FOR SEPARATING URANIUM AND FISSION PRODUCT FLUORIDES. J. M. Lenoir. Apr. 18, 1951. Decl. Feb. 16, 1957. 22p. Contract [W-7405-eng-26]. $4.80(ph OTS); $2.70(mf OTS).

An all nickel distillation column, 11/16 in.-i.d., packed 8 inches deep with 5/32 Fenske helices has been designed and constructed. The column was built to operate at 75°C and 1600 mm of Hg pressure for the purpose of purifying U from its fission products by fractionation of metal fluorides. Remote control and protective shielding are features of the design. Operation of this column with fission product contaminated UF_6 should permit evaluation of relative volatilities, the degree of fluoride deterioration, and techniques of handling the distillation. From these data it is hoped that a pilot plant, consisting of two major columns and two small supplementary columns can be rationally designed for continuous production of UF_6. (auth)

7288 A/CONF.15/P/257
EXACT DETERMINATION OF SMALL DIFFERENCES IN THE VOLATILITY OF ISOTOPES. Werner Kuhn, M. Thurkauf, and A. Narten (Univ. of Basel). 8p.

An exact determination of a small difference δ in the volatility of a mixture of isotopic molecular species is possible due to the fact that N_{eff}, the effective number of theoretical plates obtained, is under specific, simple, and well defined conditions equal to the reflux ratio R. The condition is that $R \times \delta \ll 1$ and $R \leq N_{\omega/4}$ where N_ω is the number of plates which would be observed for $R = \infty$. The validity of the relation $R = N_{eff}$ is experimentally verified in the cases of the separation of $C^{12}Cl_4$ from $C^{13}Cl_4$ and H_2O^{15} from H_2O^{16}. A packed column for determinations of δ according to this method is described. (W.D.M.)

7291 A/CONF.15/P/1267
ETUDE DU COEFFICIENT DE SEPARATION DE QUELQUES PROCESSUS CONCERNANT LES ISOTOPES DU LITHIUM. (Study of the Coefficient of Separation of Several Processes for Lithium Isotopes.) L. Perret, L. Rozand, and E. Saito (Commissariat à l'Énergie Atomique, Paris). 16p.

The coefficient of separation was determined for several processes for lithium isotope separation. Rayleigh distillation of lithium metal at a pressure of 10^{-1} to 10^{-2} mm in the temperature range from 565 to 680°C gave a separation factor between 1.032 and 1.036. Distillations at a higher vacuum 10^{-3} to 10^{-4} mm and in an argon atmosphere at a pressure of 3 mm were also investigated. The separation factors were lower. A study of the efficiency of a distillation column gave poor results in comparison with the values found for the Rayleigh distillations. Some studies were made of the electrolysis of molten lithium nitrate, the countercurrent of the salt at the cathode being obtained by the continuous addition of ammonium nitrate. An isotopic ratio of 13.14 was found in the anode compartment after 12 amp-hr, a lower value than that found by previous investigators. Experiments on the electrolysis of aqueous solutions were made with a mercury cathode. The solution was cooled by a current of water and the amalgam was recovered by a mercury current. After electrolysis, the residual lithium was analyzed chemically and isotopically. By use of Rayleigh's formula, a separation factor of 1.07 was found for lithium chloride and 1.04 for lithium hydroxide. The figures are larger than those published before. In the study of ion exchange, band displacement and a series of batch exchanges were investigated. A separation factor of 1.004 was found for the batch exchange. The band displacement gave a good total factor, although the unitary separation factors were low. The chemical exchange between LiBr in dimethylformamide solution and lithium amalgam gave a separation factor of 1.05 ± 0.025. The isotopic analyses were made by scintillation counting using the $Li^6(n,\alpha)$ reaction or mass spectrometry using lithium ions obtained by electron bombardment of LiI. (J.S.R.)

DISTILLATION 2.15

1732
PROCESS AND APPARATUS FOR THE SEPARATION OF ISOTOPES BY FRACTIONAL DISTILLATION. (to United Kingdom Atomic Energy Authority). British Patent 822,001. Oct. 21, 1959.

A fractional distillation apparatus for isotope separation is described. It consists of a stepped series of trays arranged so that vapor condenses on a sloping roof and flows by gravity to the next tray, and liquid in the tray overflows by gravity to the first tray. The space between tray and roof is evacuated. (T.R.H.)

Pilot Plant for Separation of Reactor Fuel Elements, W.R. Page, C.J. Raseman, E.I. Goodman, C.H. Scarlett. Chem Eng. Progress 51, 12, Dec 1955, 566-70 .

Investigation, in cooperation with Argonne National Laboratory, concerned with pilot plant scale separation of light and fission product fluorides and bromine fluorine compounds from uranium hexafluoride by distillation.

ELECTROCHEMICAL 2.16

See also, under PROCESS CHEMISTRY AND ENGINEERING,

SPECIAL PROCESSES--Excer (6.17.08).

17574 K-1247
Oak Ridge Gaseous Diffusion Plant, Tenn.
SEPARATION OF URANIUM ISOTOPES BY ELECTROMIGRATION IN FUSED URANIUM TETRACHLORIDE. J. W. Grisard and S. S. Kirslis. Aug. 28, 1958. Decl. Sept. 18, 1958. 13p. Contract W-7405-eng-26. $3.30 (ph OTS); $2.40(mf OTS).

Separation of uranium isotopes by countercurrent electromigration in fused uranium tetrachloride has been demonstrated on a laboratory scale. A separation factor of 1.005 ± 0.001 was obtained between cathode and anode samples with an average current of 0.13 amperes for 116 hours; this value corresponds to an electromigration separation coefficient of 1.00036 ± 0.00007. (auth)

ELECTROCHEMICAL 2.16

ELECTROLYTIC SEPARATION OF ISOTOPES. Soc. d'Electro-Chemie, d'Electro-Métallurgie et des Aciéries Electriques d'Ugine (France). British Patent 802,555. Nuclear Eng. 4, 238(1959) May.

Various electrolytical methods are in use for the separation of isotopes. All use uniform direct current and in the case of amalgamable metals such as lithium, a continuously renewed mercury cathode is provided to remove the metal from the electrolyte. This arrangement can be employed for the separation of lighter and heavier isotopes from a liquid electrolyte, derived from an isotope element such as lithium, by applying a square pulsed voltage at intervals across the electrodes of the electrolytic cell. Under the action of the pulse, the various isotopic ions reach different velocities and, as a result, the ions of the lighter isotope concentrate in the region of the cathode. By arranging for the rapid removal of the ions at each pulse the proportion of the lighter isotope in the mixture withdrawn from the electrolyte is increased. At the same time the proportion of the heavier isotopes in the remaining electrolyte rises accordingly. If the operation is continued for a sufficiently long period, progressive enrichment will result in complete separation. Details of the method and results obtainable are given for the separation of Li-6 and Li-7 using a saturated aqueous solution of lithia as the electrolyte.

CONCENTRATION OF ISOTOPES BY ELECTROMIGRATION IN AQUEOUS SOLUTION: INFLUENCE OF TEMPERATURE ON THE RELATIVE DIFFERENCE OF MOBILITY OF THE $(Rb^{85})^+$ AND $(Rb^{87})^+$ IONS. André Bonnin and Marius Chemla. Compt. rend. 246, 1189-92(1958) Feb. 24. (In French)

The relative difference of the mobility of univalent ions of Rb^{85} and Rb^{87}, in aqueous solution, was studied as a function of temperature by electromigration on paper. The difference increases from 1.1×10^{-3} at 3°C to 1.7×10^{-3} at 48°C. (tr-auth)

ELECTROCHEMICAL 2.16

9244
ELECTROREFINING FOR REMOVING FISSION PRODUCTS FROM URANIUM FUELS. Leonard W. Niedrach and Arthur C. Glamm (Knolls Atomic Power Lab., Schenectady, N. Y.). Ind. Eng. Chem. 48, 977-81 (1956) June.

The possibility of reducing the cost of reprocessing fuel from nuclear reactors by employing electrorefining is considered. This process for decontaminating uranium from fission products is described. Alloys of U with transition metals are used to obtain molten products at temperatures below the melting point of U. The effect of temperature in the range 980 to 1080°C. on cell efficiency and operation is negligible. For high efficiency low anode current densities are desirable. Bath composition has little effect on cell operation, but excessive codeposition of the bath diluent occurs if the U concentration is too low. Decontamination factors between 80 and 500 have been obtained for representative fission products. The general feasibility of the proposed electrorefining process has been demonstrated and the need for additional development work is indicated. (auth)

6679 AERE-C/R-1537(Del.)
Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.
THE SEPARATION OF FISSION PRODUCTS BY ELECTROLYTIC PRECIPITATIONS. A. C. Littlejohn. Nov. 11, 1954. Decl. with deletions Dec. 19, 1956. 16p.

Experiments have been performed which show that those fission products forming insoluble hydroxides may be precipitated as such, leaving the principal long lived constituents Sr and Cs, together with Ba and Rb in solution. The precipitations were carried out electrolytically, an anion permeable membrane separating the electrode compartments of the cell in which the fission product solution was the catholyte. The important feature of this method is that the hydroxide precipitates were obtained without the addition of alkali. The results obtained using mock fission product solutions containing approximately two curies of activity per run, indicate that up to eighty five percent of the Cs and a similar proportion of the Sr remains in solution after precipitation of all other fission products, U and Fe. These figures suggest that the method may be utilized for the isolation of Sr and Cs for the preparation of radiation sources. (auth)

7291 A/CONF.15/P/1267
ETUDE DU COEFFICIENT DE SEPARATION DE QUELQUES PROCESSUS CONCERNANT LES ISOTOPES DU LITHIUM. (Study of the Coefficient of Separation of Several Processes for Lithium Isotopes.) L. Perret, L. Rozand, and E. Saito (Commissariat à l'Énergie Atomique, Paris). 16p.

The coefficient of separation was determined for several processes for lithium isotope separation. Rayleigh distillation of lithium metal at a pressure of 10^{-1} to 10^{-2} mm in the temperature range from 565 to 680°C gave a separation factor between 1.032 and 1.036. Distillations at a higher vacuum 10^{-3} to 10^{-4} mm and in an argon atmosphere at a pressure of 3 mm were also investigated. The separation factors were lower. A study of the efficiency of a distillation column gave poor results in comparison with the values found for the Rayleigh distillations. Some studies were made of the electrolysis of molten lithium nitrate, the countercurrent of the salt at the cathode being obtained by the continuous addition of ammonium nitrate. An isotopic ratio of 13.14 was found in the anode compartment after 12 amp-hr, a lower value than that found by previous investigators. Experiments on the electrolysis of aqueous solutions were made with a mercury cathode. The solution was cooled by a current of water and the amalgam was recovered by a mercury current. After electrolysis, the residual lithium was analyzed chemically and isotopically. By use of Rayleigh's formula, a separation factor of 1.07 was found for lithium chloride and 1.04 for lithium hydroxide. The figures are larger than those published before. In the study of ion exchange, band displacement and a series of batch exchanges were investigated. A separation factor of 1.004 was found for the batch exchange. The band displacement gave a good total factor, although the unitary separation factors were low. The chemical exchange between LiBr in dimethylformamide solution and lithium amalgam gave a separation factor of 1.05 ± 0.025. The isotopic analyses were made by scintillation counting using the $Li^6(n,\alpha)$ reaction or mass spectrometry using lithium ions obtained by electron bombardment of LiI. (J.S.R.)

1304

ELECTROLYTIC SEPARATION OF METALLIC ISOTOPES. James H. Andrews, Ivan Ceresna, F. A. Rohrman, and William F. Utlaut (Univ. of Colorado, Boulder). Chem. Eng. Progr. 52, Symposium Ser. No. 19, 49-52(1956).

By use of Ni^{63} as a radioactive tracer it was found possible with electrochemical techniques to enrich the concentration of this Ni in the cathodic deposit. Nickel 63 apparently behaves more like a noble metal than do the ordinary Ni isotopes. Attempts to enrich Cd, Ag, and U by similar electrolytic means have not been successful up to this time.

A MASS SEPARATION WITH MAGNETIC FOCUSSING OF THE 2nd ORDER. B. Arcipiani, G. Barsanti, M. Fumelli, L. Musumeci, and N. Talini (C.A.M.E.N., Livorno, Italy). Nuovo cimento (10) 12, 611-15(1959) June 16.

An electromagnetic isotope separator with a 90° analyzing magnet, radius 40 cm, and second-order magnetic focusing is described. The first experimental results obtained with a low-power ion source are presented. The device is designed for the production of very pure isotopic samples for research purposes. (auth)

ELECTROMAGNETIC 2.17

11530

ELECTROMAGNETIC APPARATUS. S. W. Barnes (to U. S. Atomic Energy Commission). U. S. Patent 2,794,923. June 4, 1957.

An apparatus is described for separating charged particles by utilizing the magnetic mass spectrum thereof, and in particular to apparatus whereby the quantity of reception may be monitored to facilitate adjustment of the particle beam for maximum reception in a designated location. In the apparatus the particles are collected in closely adjacent pockets; a conducting member is adapted to occupy either of two positions in one of which it shields the entrance to one of the pockets and in the other position it does not interfere with reception of the particles. The conducting member when positioned over a pocket receives the particle current and appropriate metering equipment forms an electrical circuit therewith to indicate the particle quantity delivered to said pocket. Upon adjustment of the particle beam path for maximum current flow in said circuit the conducting member is withdrawn and the separator is ready for effective operation. (auth)

THERMALLY OPERATED VAPOR VALVE. J. G. Dorward, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 2,873,375. Feb. 10, 1959.

A valve is presented for use in a calutron to supply and control the vapor to be ionized. The invention provides a means readily operable from the exterior of the vacuum tank of the apparatus, without mechanical transmission of force, for the quick and accurate control of the ionizing arc by a corresponding control of gas flow thereto, thereby producing an effective way of carefully regulating the operation of the calutron. The invention consists essentially of a tube member extending into the charge bottle of a calutron device, having a poppet type valve closing the lower end of the tube. An electrical heating means is provided in the valve stem to thermally vary the length of the stem to regulate the valve opening to control the flow of material from the charge bottle.

CALUTRONS. E. O. Lawrence (to U. S. Atomic Energy Commission). U. S. Patent 2,871,364. Jan. 27, 1959.

Isotope separating devices known as calutrons are discussed, and a calutron having a number of transmitter units arranged to transmit a corresponding plurality of ion beams to a plurality of receiver units to increase the degree of efficiency in the use of the available evacuated tank space is presented. Various arrangements of transmitter and receiver units are attached to a removable section of the tank wall. In addition, a panel of the wall section may be removed to withdraw a particular unit without disturbing the adjustment and position of the unit with respect to its mating unit.

CALUTRONS. E. D. Kane (to U. S. Atomic Energy Commission). U. S. Patent 2,847,575. Aug. 12, 1958.

A system of calutrons is described employing a novel arrangement for maintaining a magnetic field. Several tanks, each containing an electromagnetic ion separating mechanism, are coaxially arranged in abutting relationship. The required magnetic field is provided by windings surrounding the series tanks and inclined to the axis of the series tanks so as to leave one edge wall of each tank clear and unobstructed for access into the tank. An important advantage of the disclosed construction is the calutron system does not require the use of expensive and bulky cores.

CALUTRONS 2.17.01

9120

CALUTRON RECEIVERS. E. J. Lofgren (to U. S. Atomic Energy Commission). U. S. Patent No. 2,745,965, May 15, 1956.

A calutron receiver was adapted to collect and retain a maximum percentage of the ions traveling in a selected portion of an ion beam. It has a single ion receiving pocket for collecting one isotopic component of an ion beam and has an electrode for intercepting another adjacent isotopic component for beam control purposes. Means are provided for prohibiting the scattering of material from one pocket to another in the path of a closely adjacent beam component. Further means are provided for selectively closing the ion receiving pocket to the admission of ions when beam conditions are unsatisfactory for the collection of material. (auth)

12548

ELECTROMAGNETIC SEPARATION OF THE ISOTOPES OF THE HEAVY ELEMENTS. R. S. Livingston and J. A. Martin (Oak Ridge National Lab., Tenn.). Chapter 50 of Proc. Symposium on Isotope Separation, Amsterdam, 597-609(1957).

Special high-resolution mass spectrographs have been developed for the preparation of highly enriched isotopes of the heavy elements. These special purpose isotope separators and the techniques used in handling alpha-active materials are described. (auth)

1546

PUMPING ION SOURCE. J. S. Foster, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 2,798,181. July 2, 1957.

An improved ion source is described wherein a minimum of gas is introduced into the attached analyzing chamber from the source. In operation electrons are emitted from a filament at the end of a cylindrical tube where input and output tubing are positioned to introduce the gas to be ionized. Ions created at this end of the tube travel down the tube in an axial direction under the influence of an axial magnetic field and enter a larger cylindrical tube coaxially positioned therewith, each tube being at a positive potential with respect to the filament. Two plates at a negative potential are disposed at the other end of the larger tube, and repel the forthcoming ions, thus setting up an arc discharge throughout said tubes substantially ionizing all the gas particles. (auth)

5061

ION SOURCE UNITS. E. J. Lawton et al (to U. S. Atomic Energy Commission). U. S. Patent 2,733,348, January 31, 1956.

The electrode arrangement in the arc block of a calutron ion source has been modified. It removes the prior difficulty encountered wherein the electron trimming aperture permitted quantities of vapor to escape and thus reduce the efficiency of the ion source. This is accomplished by making the cathode a structural part of the arc chamber closure. (auth)

5075

CALUTRON RECEIVER. H. F. Weaver and C. M. Van Atta (to U. S. Atomic Energy Commission). U. S. Patent 2,736,811, February 28, 1956.

A calutron receiver is described having a beam viewing face defining one or more beam receiving areas, such as slots or electrode surfaces, properly shaped or oriented to fit the focal patterns of the beam components respectively to be received thereby with as high a degree of accuracy as possible, and without employing elements having dished or warped surfaces. The beam viewing faces are constructed in a manner particularly suited for duplication in large numbers and yet adapted to fit the warped or non-planar focal patterns of the beams with a high degree of accuracy. (auth)

12549

SPECIAL ISOTOPE SEPARATOR FOR IDENTIFICATION OR PURIFICATION OF RADIOACTIVE SPECIES. R. S. Livingston and J. A. Martin (Oak Ridge National Lab., Tenn.). Chapter 51 of Proc Symposium on Isotope Separation, Amsterdam, 610-14(1957).

The preliminary development of a small 180° mass spectrograph designed to operate in the framework of a standard 24-in.-radius machine is discussed. The unit requires less than one gram of feed material and provides very high resolution. The performance with heavy elements at elevated temperatures has been measured. (W.D.M.)

CALUTRONS 2.17.01

ELECTROMAGNETIC ISOTOPE SEPARATOR IN GOTHENBURG. O. Almen, G. Bruce, and A. Lunden (Chalmers Univ. of Tech., Gothenburg). Nuclear Instr. 2, 249-60(1958) Apr.

A 90° electromagnetic isotope separator with a beam radius of 100 cm is described. Using an acceleration voltage of 50 kv, ion currents of up to a few hundred μa can be handled. The ion current and resolving power can be varied within wide limits by adjusting the position of the lens system during operation. Two types of magnetic ion sources have been used to prepare targets for nuclear reaction studies and samples for beta- and gamma-ray spectroscopy. (auth)

8581

RECONSTRUCTION OF THE ISOTOPE SEPARATOR AT THE NOBEL INSTITUTE OF PHYSICS. Torsten Alväger and Jan Uhler. Arkiv Fysik 13, 145-63(1958).

At the Nobel Institute an electromagnetic isotope separator has been working since 1948. Applications of this have been separations of radioactive material used in nuclear spectroscopy and preparation of targets of stable isotopes for nuclear reaction studies. However, such work in the lead region emphasized the importance of better resolution, which was found to be attainable by using the analyzing magnet as a symmetrical sector field. To fulfil the new requirements, an extensive reconstruction of the isotope separator has been made, including a new vacuum system and lens system. Further, the instrument has been made two directional focusing by an electrostatic cylinder lens, with which it is possible to diminish the line height by a factor of 5, or to 10 mm, without any appreciable defocusing. To analyze the focusing properties a partly new method has been developed which makes it possible to make continuous observation of the mass lines during the separation. The resolving power obtained is about 1400; the over-all efficiency corresponding to this value is a few percent. (auth)

5062

CALUTRON. E. O. Lawrence et al (to U. S. Atomic Energy Commission). U. S. Patent 2,733,349, January 31, 1956.

An electromagnetic device is utilized for moving mechanical elements back and forth between predetermined positions in a calutron. Heretofore, during focusing of a calutron ion beam on the viewing face of a receiver, a suitable door mounted on the receiver is closed in order to avoid contaminating the pocket or pockets of the receiver. This was accomplished by mechanical linkages which required an air seal where they passed through the walls of the tank so as to enable remote operation from the exterior of the tank. By providing a mechanism disposed within a calutron tank and adapted to make an auxiliary electrodynamic or electromagnetic use of the magnetic field in the tank for opening and closing the aforesaid doors, the need for such exteriorly operated mechanical linkage is eliminated. (auth)

391

THE FIRST EXPERIMENT OF DOUBLE MONOCHROMATION IN THE ELECTROMAGNETIC SEPARATION OF ISOTOPES. Ch. Cassignol. J. phys. radium 17, Suppl. No. 11, 113A-15A(1956) Nov. (In French)

After enumerating the causes liable to limit enrichment in isotopic separations, an electrostatic double monochromator is described. The first results show a gain of one order of magnitude in the enrichment coefficient, compared with ordinary separations. (auth)

3077

CALUTRONS. E. O. Lawrence (to U. S. Atomic Energy Commission). U. S. Patent 2,727,150. December 13, 1955.

A calutron transmitter having an ion source at a high positive potential with respect to the calutron tank is modified to minimize the high voltage current drain to reduce wear and erosion of the electrodes. This is achieved by minimizing the volume of the electric field surrounding the ion source in which electron oscillation may occur, thereby reducing the total path traversed by the oscillating electrons and thus decreasing the overall ionization through the gaseous region immediately surrounding the ion source. The structure for accomplishing this is comprised of an electric shield surrounding the ion source having a concavity formed in opposing walls thereof, a second electric shield disposed between the first electric shield and the ion source and having a pair of opposing fins extending therefrom into the concavity and substantially normal to the magnetic field. (auth)

ION SOURCES 2.17.02

5487

SYSTEMATIC INVESTIGATION OF A MAGNETIC ION SOURCE FOR AN ELECTROMAGNETIC ISOTOPE SEPARATOR. O. Almén and K. O. Nielsen (Univ. of Copenhagen, Denmark). Nuclear Instr. 1, 302-22(1957) Dec.

The properties of a magnetic ion source with oscillating electrons are studied. The ion source is operated in connection with an electromagnetic isotope separator. Special interest is devoted to the obtainable ion currents, the resolving power of the instrument, and the efficiency of the ion source. The ion current and the resolving power can be varied within wide limits. However, if the ion source is operated at conditions corresponding to maximum resolving power, it is found that the ion current is limited by space charge in the ion extracting device. By measurements of the parameters of the ion source, performed at maximum resolving power, an investigation of the plasma discharge was possible. It was found that, for maximum resolving power, a constant ion production rate was required, determined only by the extracted ion current. Applying this result the influence of different factors on the efficiency of the ion source was calculated. The efficiency appeared to be proportional to the length of the discharge chamber and to the ionization cross section. This was also verified experimentally. (auth)

5486

THE DEVELOPMENT OF MAGNETIC ION SOURCES FOR AN ELECTROMAGNETIC ISOTOPE SEPARATOR. K. O. Nielsen (Univ. of Copenhagen, Denmark). Nuclear Instr. 1, 289-301(1957) Dec.

The paper gives a survey of several ion sources of the magnetic type, which have been used in connection with the electromagnetic isotope separator in Copenhagen. The first types constructed for handling gases are described briefly, while ion sources for solids are discussed in greater detail. The temperature of the discharge chamber can be raised to about 1100°C. The evaporation rate is controlled by the temperature of the sublimation furnace. Problems in connection with the maintenance of optimal pressure in the discharge chamber by adjusting the furnace temperature are discussed. (auth)

8127

ARC REGULATOR FOR CALUTRON ION SOURCE. R. DeLiban (to U. S. Atomic Energy Commission). U. S. Patent No. 2,745,964, May 15, 1956.

Arc regulators for calutron ion sources were modified to include means for protecting the filamentary cathode of the ion generator from electrical abuse, whereby longer cathode life is obtained. Further, the power lines feeding the arc supply and the filamentary cathode supply are near ground potential since the present device allows the operation of the arc regulator unit and its associated controls at ground potential regardless of the high potentials applied to the ion generator unit. (auth)

8124

ION PRODUCING MECHANISM. F. F. Oppenheimer (to U. S. Atomic Energy Commission). U. S. Patent No. 2,745,017, May 8, 1956.

The density of an ion beam can be increased by increasing the percentage of charged material ionized and projected through the calutron. An important feature of the ion producing mechanism resides in the combination of an ionizing chamber having an exit opening, a pair of accelerating electrodes disposed without the ionization chamber and closely adjacent to the exit therefrom, and a crescent shaped filament being so disposed as to project a concentrated stream of electrons across the ionizing chamber behind the exit. Another feature of the invention resides in causing the ionizing electron stream to travel close to the boundary of the arc plasma present in the ionizing chamber. (auth)

5079

ION SOURCE FOR A CALUTRON. W. M. Brobeck (to U. S. Atomic Energy Commission). U. S. Patent 2,737,589, March 6, 1956.

A calutron ion source having an improved electrode arrangement productive of a uniform and copious supply of ions consists of the following features: an improved mount for the ion source which increases the efficiency of the vacuum seal; independent heating elements for the vaporization chamber and the ionization chamber; a water cooled cathode capable of adjustment while the source is in operation; accelerating electrodes mounted as unitary elements but separately adjustable; and a novel structure for tensioning the source mount against the calutron tank. (auth)

ION SOURCES 2.17.02

5064

MAGNETIC FIELD REGULATOR. K. G. MacLeish (to U. S. Atomic Energy Commission). U. S. Patent 2,735,044, February 14, 1956.

An improved electromagnetic field regulator is described which is capable of providing the accuracy of magnet field regulation necessary in the electromagnetic separation of isotopes. It provides an improved regulator capable of maintaining the flux between pole faces of a magnet constant within at least one part in 5000 for sudden changes and one part in 1000 for slow drift. It also provides the above stated accuracy without the attendant oscillations peculiar to any system striving for such sensitivity. It is generally comprised of means to compare the input signal to a reference voltage, a converter to change the result of the comparison to an alternating current signal, appropriate amplifiers, rectifiers and variable impedances, a dampening transformer having its primary winding connected in the magnet winding circuit and its secondary winding connected across the converter thereby providing an opposing regulator input signal for particular load fluctuations. (auth)

5060

REACTOR FOR CALUTRON ION SOURCE. R. de Liban (to U. S. Atomic Energy Commission). U. S. Patent 2,733,347, January 31, 1956.

This reactor is comprised of an ion source having an anode and a cathode, a resistor connected in series with a pair of feeders for supplying heating current to the cathode through the resistor, a variable impedance apparatus connected across the resistor including gas discharge device means, and means for controlling the gas discharge device means in accordance with the arc current between the anode and the cathode whereby the current to the cathode is controlled to maintain the arc current substantially constant. (auth)

5058

REGULATOR FOR CALUTRON ION SOURCE. L. F. Wouters (to U. S. Atomic Energy Commission). U. S. Patent 2,733,345, January 31, 1956.

This regulator is comprised of an ion generator having an electron emissive cathode, a bombardment cathode and an anode, a source of bombardment current supply connected between the electron emissive cathode and the bombardment cathode, a triode connected in series with the bombardment current supply, a source of arc current supply connected between the bombardment cathode and the anode, a second triode, a resistor connected in series with the arc current supply and across the input of the second triode. An important feature is the connection of means between the triodes for controlling the impedance of the first triode in accordance with the arc current of the ion generator. (auth)

5059

ION PRODUCING MECHANISM. F. Oppenheimer (to U. S. Atomic Commission). U. S. Patent 2,733,346, January 31, 1956.

A modified ion generator for a calutron is comprised of a gas source, an ionizing chamber open at both ends, a slot running along one wall from end to end, an electron emissive filament at one end of the chamber, an anode at the other end and a means for maintaining an arc between the anode and the filament. This results in an arc which is improved in uniformity both in time and throughout its length. (auth)

5057

ION GENERATOR REGULATOR. R. de Liban (to U. S. Atomic Energy Commission). U. S. Patent 2,733,344, January 31, 1956.

The cathode of the calutron ion source is heated by an alternating current supply which is also rectified to supply the arc potential between the cathode and anode. The important feature is a phasing circuit for controlling the current through the ion source cathode inversely in accordance with the current drawn by the arc to maintain the arc current constant. (auth)

7298 A/CONF.15/P/2303

AN ION SOURCE FOR STABLE ISOTOPE SEPARATION. P. M. Morozov, B. N. Makov, M. S. Ioffe, B. G. Brezhnev, and G. M. Fradkin (U.S.S.R.) 11p.

A universal ion source designed for stable isotope separation by electromagnetic means is described. A description is given of the investigations on the properties of a gas discharge occurring in UCl_4 vapors in a longitudinal magnetic field of the separation plant. The investigations show the dependence of the formation process of ions of different masses on the gas discharge parameters in the case of a complex molecule UCl_4. The practical results obtained with this source in the isotope separation of uranium and other elements are presented. For the uranium isotope separation the ion current (U^+) reached 0.3 a and the separation factor (for uranium) amounted to 25 to 30%. Similar data on the separation of isotopes with intermediate masses are given. (auth)

ION SOURCES 2.17.02

5080

ION SOURCE FOR A CALUTRON. E. J. Lofgren (to U. S. Atomic Energy Commission). U. S. Patent 2,737,590, March 6, 1956.

The mount for a calutron ion source has been improved. It provides mechanism for adjusting the relative positions of the exit slit from the arc chamber and the passage between the accelerating electrodes through several different planes with respect to the other elements of the calutron. An important feature of the invention resides in the combination of gimbal rings in which an ion source support stem is suspended, with mechanism constructed to provide both axial translation and rotation of the support stem. (auth)

5074

CHARGE RECEPTACLES FOR USE IN ION SOURCE UNITS. A. F. Clark (to U. S. Atomic Energy Commission). U. S. Patent 2,736,810, February 28, 1956.

A calutron ion source is provided with an improved arrangement controllable from the exterior of the tank for opening a sealed charge receptacle into communication with the charge ionization chamber of the source. (auth)

7299 A/CONF.15/P/2304

INFLUENCE OF ELECTRIC FIELDS IN ION BEAMS ON ELECTROMAGNETIC SEPARATION OF STABLE ISOTOPES. M. V. Nezlin and P. M. Morozov (U.S.S.R.) 15p.

The results of an experimental study of the volume charge compensation of intense beams in electromagnetic isotope separation plants are presented. It is shown that in the ion beam of the separation plant there exist considerable electric fields responsible for the beam defocusing and for the decrease in the enrichment factor. Factors responsible for the creation in the ion beam of the high electric fields causing the sharp limitation of the ion beam current in the separation plant are established and methods for their elimination are found. The practical application of these methods of isotope separation permitted removal of the limitation and separation of different elements at maximum ion beam currents, e.g., 0.4 a; 0.45 a, and 0.7 a for the isotope separation of zinc, cadmium, and calcium isotopes, respectively. (auth)

METHODS 2.17.03

5423 NP-6216

A NOVEL MAGNETO-IONIC MEANS FOR SEPARATING ISOTOPES IN VERY LARGE QUANTITIES. Joseph Slepian. Nov. 1956. 17p.

Isotopes of ions of the same kinetic energy are sent by a magnetic field on slightly different paths, permitting their separation as in the mass spectrometer. The current, however, is limited to a very low value by their space charge. Their space charge can be eliminated by the presence of electrons substantially at rest, as in the Calutron, but oscillations inherently set themselves up at a new value of limiting current which is again too low for practical separation. A new Magneto-Ionic Expander Isotope Separator which has no space charge limit is described. This method of isotope separation is believed to be more economical than any other known method. (auth)

ISOTOPE ENRICHMENT PROCESS. J. M. Carter, et al. (to U. S. Atomic Energy Commission). U. S. Patent No. 2,758,006, August 7, 1956.

An improved method is suggested for processing material enriched in a particular isotope by means of two stages of electromagnetic separation. The non-enriched material from the first stage calutron and the depleted material from the second stage calutron are combined and reworked as feed to the first stage. Likewise, the non-enriched material from the second stage and the enriched material from the first stage are combined and used as feed to the second stage. The enriched material from the second stage calutron is recovered as product. (auth)

5065

AUTOMATIC VAPOR CONTROL. B. T. Wright, et al (to U. S. Atomic Energy Commission). U. S. Patent 2,735,943, February 21, 1956.

A control apparatus has been developed to insure a stable arc in an ion generator by regulating the vapor flow thereto. It provides a simple electrical arrangement for automatically regulating a calutron vapor valve so as to maintain a steady flow of vapor from a vapor source to an ionization chamber whereby a more stable arc may be maintained within the ionization chamber. The flow of vapor to the ionization chamber is a function of the current flow to an acceleration electrode disposed adjacent the ionization chamber. (auth)

METHODS 2.17.03

7300 A/CONF.15/P/2305
RAZDELENIE IZOTOPOV NA ELEKTROMAGNITNYKH USTANOVKAKH V SOVETSKOM SOYUZE. (Separation of Isotopes by Electromagnetic Method in the U.S.S.R.) V. S. Zolotarev, E. G. Komar, and A. I. Il'in (U.S.S.R.). 23p.

A description is given of the electromagnetic separation plants used for the production of enriched isotopes in Russia. The characteristics of the electrical and vacuum equipment of the plants are given, and the design of an arc ion source is described. To separate isotopes of elements with low vapor pressures, high temperature ion sources with the crucibles heated either directly or by electron bombardment are used. Special ion sources which are used in the separation of alkaline elements or rare elements are described.

14100 ORNL-2482
Oak Ridge National Lab., Tenn.
CHEMISTRY ASSOCIATED WITH THE ELECTROMAGNETIC SEPARATION OF CHROMIUM ISOTOPES. Boyd Weaver, R. L. Bailey, W. C. Davis, F. M. Scheitlin, C. W. Sheridan, and F. B. Thomas. Aug. 14, 1958. 7p. $0.50(OTS).

Chemical research and production efforts which support the electromagnetic separation of the stable isotopes of chromium include the preparation of charge material, removal of separated material from collectors, and product purification. (auth)

7365
THE POSSIBILITIES OF APPLYING MULTIPLE MONOCHROMATIZATION TO THE ELECTROMAGNETIC SEPARATION OF ISOTOPES. Charles Cassignol. Compt. rend. 246, 1413-16(1958) Mar. 3. (In French)

A theory of isotopic contamination suggested primarily by experimentation with a double electrostatic monochromatization apparatus gives by numerical application to other systems of multiple monochromatization some isotopic enrichment values which are greater by several orders of magnitude than the values obtained today. (J.S.R.)

PRODUCTION AND UTILIZATION OF ELECTROMAGNETICALLY ENRICHED ISOTOPES. A. Bisi. Energia nucleare (Milan) 5, 85-9(1958) Feb. (In Italian)

This paper describes the characteristics of electromagnetic isotope separators (calutron) and the utilization of electromagnetically enriched isotopes. The activity performed in this field by the Physics Institute of the Milano Polytechnic is also mentioned. (auth)

7936
THE ELECTROMAGNETIC SEPARATION OF ISOTOPES. B. De Michelis. Energia nucleare (Milan) 5, 175-86(1958) Mar. (In Italian)

Isotope separation by electromagnetic methods is illustrated in this paper. A description is given of various types of current sources, extraction systems, aberration causes, spatial charge neutralization processes, ion flow fluctuation effect, and isotope receivers. The paper ends with a brief mention of the utilization and application of separated isotopes. (auth)

ELECTROMAGNETIC ISOTOPE SEPARATORS AND APPLICATIONS OF ELECTROMAGNETICALLY ENRICHED ISOTOPES. J. Koch, ed., R. H. V. M. Dawton, M. L. Smith, and W. Walcher. Amsterdam, North Holland Publishing Company, 1958. 324p.

The first two parts of the book are devoted to the technical description of isotope separators and the applications of enriched isotopes. In the third part of the book a general account is given of a number of fundamental physical problems, which are of importance in separator design and which have a special bearing on the future technological developments. (W.L.H.)

5488
NOTE ON THE PREPARATION OF ANHYDROUS RARE-EARTH CHLORIDES FOR THE ELECTROMAGNETIC ISOTOPE SEPARATOR. Bror Skytte Jensen (Univ. of Copenhagen, Denmark). Nuclear Instr. 1, 323(1957) Dec.

A quick and simple procedure for preparing anhydrous rare-earth chlorides in amounts ranging from 50 to 300 mg is desirable for use in charging the isotope separator. The method chosen is an adaptation of the well-known ammonium chloride method. The procedure to be described has been used successfully for the preparation of the anhydrous chlorides of Gd, Dy, Er, Yb, and Lu. The yield of the transformation of the oxides into the chlorides is 70 to 90% depending on circumstances. (auth)

METHODS 2.17.03

4619
METHOD AND APPARATUS FOR COLLECTING ISOTOPES. W. E. Leyshon (to U. S. Atomic Energy Commission). U. S. Patent 2,802,108. Aug. 6, 1957.

A method and apparatus for collecting isotopes having a high vapor pressure, such as isotopes of mercury, in a calutron are described. Heretofore, the collected naterial would vaporize and escape from the ion receiver as fast as it was received. By making the receiver of pure silver, the mercury isotopes form a nonvolatile amalgam with the silver at the water cooled temperature of the receiver, and the mercury is thus retained.

9378 ORNL-2275
Oak Ridge National Lab., Tenn.
RETENTION OF ELECTROMAGNETICALLY SEPARATED INERT-GAS ISOTOPES. H. B. Greene. July 12, 1957. 21p. Contract W-7405-eng-26. $0.25(OTS).

Experimentation has been undertaken to establish that inert-gas ions produced in the electromagnetic separators can be collected and retained on metal surfaces by means of adsorption. A technique has been worked out whereby target surfaces quickly saturated at ordinary reception rates can be renewed by continuous or periodic vaporization and condensation of a suitable metal. Subsequent outgassing of these targets for recovery of the collected isotopes yields many times more gaseous impurities than desired product, and a practical system for cleaning the inert gases to chemical purities of 99.5% or better is described. From one run, lasting about 100 hr, during which 5.3 ma-hr (4.4 ml) of A^{40} was monitored, approximately 2.0 ml of natural A^{36} was recovered. About 1.5 ml of this was enhanced from a natural isotopic abundance of 0.34% to about 70%. From the same run, 118 ml of A^{40} was recovered, most of which assayed better than 99.98%. (auth)

6452
ELECTROMAGNETIC SEPARATION BY HERMES. Nuclear Power 2, 132-4(1957) Apr.

The Heavy Element Radioactive Material Electromagnetic Separator is in principle a mass spectrograph. Positively charged ions travelling at constant high velocity enter a field of an electromagnet where they are deflected from their straight path into an arc of a circle whose radius depends on the mass of the particle. The apparatus is versatile and could be used for any element, but at the present it is being used to separate and collect in the milligram range, quantities of the four Pu isotopes, 239 to 242, in order to investigate their fission absorption cross sections. (W.L.H.)

GAS RECOVERY SYSTEM. John Ise, Jr., and George P. Millburn (to U. S. Atomic Energy Commission). U. S. Patent 2,784,799. March 12, 1957.

A gas recirculation system is described in which a valuable isotope, exhausted from a cyclotron diffusion pump is recompressed and piped through a filter which removes all substances foreign to the desired isotope. The purified gas is further recompressed and recirculated to the ion source where the isotope is reionized and reaccelerated. This recirculation system will permit the recovery and reuse of an otherwise prohibitively expensive material. (auth)

12550
PRESENT STATUS OF ELECTROMAGNETIC SEPARATION OF STABLE ISOTOPES AT THE OAK RIDGE NATIONAL LABORATORY. L. O. Love, W. A. Bell, Jr., W. K. Prater, G. M. Banic, and A. E. Cameron (Oak Ridge National Lab., Tenn.). Chapter 52 of Proc. Symposium on Isotope Separation, Amsterdam, 615-21(1957).

The total collection for 10 years has been 15,311 grams. Of this, 13,656 grams have been processed for chemical recovery of the separated materials, yielding 7,670 grams. An increase in output is possible by increasing the retention of the chemical processing. A summary of the isotopes separated for the last two years is presented. (W.D.M.)

391
THE FIRST EXPERIMENT OF DOUBLE MONOCHROMATION IN THE ELECTROMAGNETIC SEPARATION OF ISOTOPES. Ch. Cassignol. J. phys. radium 17, Suppl. No. 11, 113A-15A(1956) Nov. (In French)

After enumerating the causes liable to limit enrichment in isotopic separations, an electrostatic double monochromator is described. The first results show a gain of one order of magnitude in the enrichment coefficient, compared with ordinary separations. (auth)

AN ELECTROMAGNETIC ISOTOPE SEPARATOR. René Bernas (College de France, Paris and Charles Cassignol (Centre d'Etudes Nucléaires de Saclay, France). L'Onde Électrique 35, 1094-1100(1955) Nov. (In French)

The principles of electromagnetic separation of isotopes are reviewed, and detailed descriptions are given of the C.E.A. electromagnetic separator. (B.J.H.)

URANIUM 2.17.04

12550

METHOD OF RECOVERING URANIUM. (to United Kingdom Atomic Energy Authority). British Patent 812,793. Apr. 29, 1959.

A calutron processing scheme is described which includes electrolytic removal of U from collectors. The UCl_4 and other water solubles are removed with hot water washes, sieved, oxidized by H_2O_2, filtered, evaporated, precipitated with NH_4OH, redissolved in H_2SO_4, and electrolyzed. This electrolyzed solution is combined with the 0.01 N H_2SO_4 solution in which the collector was electrolyzed to remove metallic U. The U^{4+} is precipitated by NH_4OH and the $U(OH)_4$ is calcined to UO_2. The UO_2 is then chlorinated to UCl_4. (T.R.H.)

13386

PROCESSES OF RECLAIMING URANIUM FROM SOLUTIONS. L. R. Zumwalt (to U. S. Atomic Energy Commission). U. S. Patent 2,873,167. Feb. 10, 1959.

A process is described for reclaiming residual enriched uranium from calutron wash solutions containing Fe, Cr, Cu, Ni, and Mn as impurities. The solution is adjusted to a pH of between 2 and 4 and is contacted with a metallic reducing agent, such as iron or zinc, in order to reduce the copper to metal and thereby remove it from the solution. At the same time the uranium present is reduced to the uranous state. The solution is then contacted with a precipitate of zinc hydroxide or barium carbonate in order to precipitate and carry uranium, iron, and chromium away from the nickel and manganese ions in the solution. The uranium is then recovered from this precipitate.

RECOVERY OF URANIUM FROM TUNGSTEN. K. Newnam (to U. S. Atomic Energy Commission). U. S. Patent 2,872,394. Feb. 3, 1959.

A method is presented for the recovery of uranium which has adhered to tungsten parts in electromagnetic isotope separation apparatus. Such a tungsten article is dissolved electrolytically in 20% NaOH by using the tungsten article as the anode. The resulting solution, containing soluble sodium tungstate and an insoluble slime, is then filtered. The slime residue is ignited successively with sodium nitrate and sodium pyrosulfate and leashed, and the resulting filtrates are combined with the original filtrate. Uranium is then recovered from the combined filtrates by diuranate precipitation.

PROCESS FOR THE PURIFICATION OF URANIUM. S. Rosenfeld (to U. S. Atomic Energy Commission). U. S. Patent 2,869,981. Jan. 20, 1959.

A process is described for reclaiming uranium values from aqueous solutions containing U, Fe, Ni, Cu, and Cr comprising treating the solution with NH_3 to precipitate the U, Fe, and Cr and leaving Cu and Ni in solution as ammonia complex ions. The precipitate is chlorinated with CCl_4 at an elevated temperature to convert the U, Fe, and Cr into their chlorides. The more volatile $FeCl_3$ and $CrCl_3$ are separated from the UCl_4. The process is used when U is treated in a calutron, and composite solutions are produced which contain dissolved products of stainless steel.

1325 ORNL-2381

Oak Ridge National Lab., Tenn.

HIGH ENRICHMENT OF URANIUM-235. B. Harmatz, H. C. McCurdy, F. N. Case, and R. S. Livingston. Nov. 11, 1957. 26p. Contract W-7405-eng-26. $0.75(OTS).

This report summarizes the results from three programs for the production of highly enriched U^{235} by the electromagnetic process. Products and enrichments obtained are: (1) 80 grams of 99.9% U^{235}, (2) 1100 grams of 99.7% U^{235}, and (3) 8 grams of 99.994% U^{235}. These materials have been made available for use on Atomic Energy Commission projects. An analysis of certain features of the process is made for its possible use in the separation of mass fractions 233 and 235 from 232, 234, and 235. (auth)

11505

PROCESS OF RECOVERING URANIUM FROM CALUTRON WASH SOLUTIONS. R. Q. Boyer (to U. S. Atomic Energy Commission). U. S. Patent 2,796,393. June 18, 1957.

A process is given for treating calutron wash solutions to reclaim U values therefrom. The parts of a calutron upon which U is deposited are washed with a solvent for the U, whereby UO_2^{2+} and the ions of metal impurities such as Fe, Cr, and Ni are introduced in the wash solution. The wash solution is first subjected to a reducing treatment to convert the UO_2^{2+} into U^{4+} in the solution, and then treated with a stoichiometric excess of oxalic and hydrochloric acids to precipitate the U as $U(C_2O_4)_2$ away from metal impurities in the solution. The wet $U(C_2O_4)_2$ precipitate is then contacted with a suitable liquid drying agent, whereby the wet $U(C_2O_4)_2$ precipitate is dried, and thereafter the dried $U(C_2O_4)_2$ precipitate is calcined to produce a uranium oxide. (auth)

URANIUM 2.17.04

9538

PROCESS OF RECOVERING URANIUM. M. D. Kamen (to U. S. Atomic Energy Commission). U. S. Patent 2,790,701. Apr. 30, 1957.

A process is presented for the securing of U values from deposits formed on stainless steel parts of a calutron isotope separator. The deposits are dissolved and the U is accompanied into solution by varying amounts of Fe, Cr, and Ni. This wash solution is treated with NH_3 which precipitates U, Fe and Cr away from any Ni present. The precipitate is collected and dissolved in HCl, and the resulting solution extracted with ether to extract the Fe into the ether and away from the U and Cr. The HCl solution is then heated to drive off chlorides, and HNO_3 is added to convert the U and Cr to nitrates. This HNO_3 solution is then contacted with ether to extract the U away from the Cr, and the ether extract is then separated and the U recovered therefrom. (auth)

8096

ELECTROLYTIC CELLS. R. Q. Boyer (to U. S. Atomic Energy Commission). U. S. Patent No. 2,743,228, Apr. 24, 1956.

Electrolytic cells were adapted for use in conjunction with the reduction and purification of wash solutions derived from calutrons employed in the calutron method of producing U enriched with U^{235}. The cell has a casing comprised of an upper portion removably secured to a lower portion with a plurality of alternately disposed anode and cathode compartments separately enclosed within the upper portion. These compartments have porous walls and partitioning members and are adapted to contain a first body of electrolyte and a second body of circulating electrolyte mixed with a solution to be treated. The cathode compartments each have movable cathodes which dip successively into a Hg pool disposed in the lower portion of the cell casing and into the aforesaid body of circulating electrolyte. In operation, the compartments are initially filled with an electrolyte comprising 3N HCl; then the solution to be treated is conducted through the cathode compartment, with the cathode operating as described, whereby the solution is reduced in the cell. (auth)

7286 Y-697

Oak Ridge National Lab., Tenn.

THE SEPARATION AND COLLECTION OF U-236 BY THE ELECTROMAGNETIC PROCESS. H. W. Savage and P. E. Wilkinson. Nov. 30, 1950. Decl. Jan. 6, 1956. 136p. Contract W-7405-eng-26. $0.65(OTS).

Equipment is described which was used to separate and collect small, highly enriched samples of U^{236} from a very small quantity of charge material using a special 12-in.-radius calutron. Appended are details of methods used for estimations of product purity, the preliminary experimental program, design of the calutron unit, handling equipment, ion source development, receiver development and beam studies, charge chemistry and recycle operation, the chemical purification of U^{236}, operation of the calutron equipment, and health hazards. (C.H.)

PROCESS FOR SEPARATING URANIUM. (to United Kingdom Atomic Energy Authority)(U.S.A.). British Patent 794,490. Nuclear Eng. 3, 510(1958) Nov.

U.S. Patents Nos. 2,709,222, 2,758,006, and 2,771,340 refer to the production of uranium enriched with U^{235} employing the "calutron" method for separating the constituent isotopes of an element in several stages. A final salvage treatment is important because an oxalate solution of relatively large volume is left which contains singly enriched uranium. The usual process, however, is difficult to operate on a large scale. In the new method, the solution is admitted to the anode compartment of a mercury cathode electrolytic cell whose cathode compartment contains a hydrochloric acid solution. The compartments are separated by an ion-permeable barrier of a ceramic insulating material which prevents mechanical passage of liquid. The uranium containing solution is then subjected to electrolysis in the cell causing transfer of uranium ions to the acidic solution in the cathode compartment. The metallic impurity is deposited in the mercury of the cathode.

URANIUM 2.17.04

PROCESS OF RECOVERING URANIUM. J. M. Carter and C. E. Larson (to U. S. Atomic Energy Commission). U. S. Patent 2,855,270. Oct. 7, 1958.

A process is presented for recovering uranium values from calutron deposits. The process consists in treating such deposits to produce an oxidized acidic solution containing uranium together with the following impurities: Cu, Fe, Cr, Ni, Mn, Zn. The uranium is recovered from such an impurity-bearing solution by adjusting the pH of the solution to the range 1.5 to 3.0 and then treating the solution with hydrogen peroxide. This results in the precipitation of uranium peroxide which is substantially free of the metal impurities in the solution. The peroxide precipitate is then separated from the solution, washed, and calcined to produce uranium trioxide.

PROCESS FOR THE RECOVERY AND PURIFICATION OF URANIUM DEPOSITS. J. M. Carter and M. D. Kamen (to U. S. Atomic Energy Commission). U. S. Patent 2,856,263. Oct. 14, 1958.

A process is presented for recovering uranium values from UCl_4 deposits formed on calutrons. Such deposits are removed from the calutron parts by an aqueous wash solution which then contains the uranium values in addition to the following impurities: Ni, Cu, Fe, and Cr. This impurity bearing wash solution is treated with an oxidizing agent, and the oxidized solution is then treated with ammonia in order to precipitate the uranium as ammonium diuranate. The metal impurities of iron and chromium, which form insoluble hydroxides, are precipitated along with the uranium values. The precipitate is separated from the solution, dissolved in acid, and the solution again treated with ammonia and ammonium carbonate, which results in the precipitation of the metal impurities as hydroxides while the uranium values remain in solution.

PROCESSES OF RECOVERING URANIUM FROM A CALUTRON. D. O. Baird and L. R. Zumwalt (to U. S. Atomic Energy Commission). U. S. Patent 2,843,451. July 15, 1958.

An improved process is described for recovering the residue of a uranium compound which has been subjected to treatment in a calutron, from the parts of the calutron disposed in the source region upon which the residue is deposited. The process may be utilized when the uranium compound adheres to a surface containing metals of the group consisting of copper, iron, chromium, and nickel. The steps comprise washing the surface with an aqueous acidic oxidizing solvent for the uranium whereby there is obtained an acidic aqueous solution containing uranium as uranyl ions and metals of said group as impurities, treating the acidic solution with sodium acetate in the presence of added sodium nitrate to precipitate the uranium as sodium uranyl acetate away from the impurities in the solution, and separating the sodium uranyl acetate from the solution.

14452

METHOD OF SEPARATING ISOTOPES OF URANIUM IN A CALUTRON. F. A. Jenkins (to U. S. Atomic Energy Commission). U. S. Patent 2,833,927. May 6, 1958.

Mass separation devices of the calutron type and the use of uranium hexachloride as a charge material in the calutron ion source are described. The method for using this material in a mass separator includes heating the uranium hexachloride to a temperature in the range of 60 to 100°C in a vacuum and thereby forming a vapor of the material. The vaporized uranium hexachloride is then ionized in a vapor ionizing device for subsequent mass separation processing.

EUROPIUM 2.18

10824 KAPL-M-JR-7
Knolls Atomic Power Lab., Schenectady, N. Y.
A LABORATORY PROCEDURE FOR THE RECOVERY OF EUROPIUM-OXIDE FROM EU_2O_3-STEEL CERMETS.
Joseph Rynasiewicz. July 11, 1956. 7p. Contract W-31-109-eng-52. $1.80(ph OTS); $1.80(mf OTS).

FLUORINATION AND HYDRO-FLOURINATION 2.19

See also, under PROCESS CHEMISTRY AND ENGINEERING,

SPECIAL PROCESSES--Fluorox (6.17.09),
Flurex (6.17.10),
Fused Salt-Fluoride Volatility (6.17.11).

13008 CF-58-6-86
Oak Ridge National Lab., Tenn.
VOLATILITY STUDIES OF SOME FISSION PRODUCT FLUORIDES. W. A. Brooksbank, Jr., R. J. Carter, and M. F. Osborne. June 25, 1958. 22p. Contract [W-7405-eng-26]. $4.80(ph OTS); $2.70(mf OTS).

A preliminary study of the volatility behavior of molybdenum indicated that MoF_5 was converted to MoF_6 by F_2; MoF_6 and Tc fluoride are absorbed on NaF at 100°; technetium fluoride is more strongly held than molybdenum fluoride on NaF; MoF_6 may not be completely trapped by a dry ice trap. The behavior of volatile fission product fluorides was such that (a) Ru and Nb fluorides were volatile from fused salts during fluorination, (b) Mo and technetium were not volatile during hydrofluorination but were in excess F_2 > 100°C. (auth).

FLOURINATION AND HYDRO-FLOURINATION 2.19

7160 ANL-5441
Argonne National Lab., Lemont, Ill.
THE BEHAVIOR OF URANIUM, THORIUM, AND OTHER SELECTED MATERIALS IN BROMINE TRIFLUORIDE, BROMINE PENTAFLUORIDE, CHLORINE TRIFLUORIDE, AND FLUORINE AT ELEVATED TEMPERATURES.
Lawrence Stein and Richard C. Vogel. May 1955. 20p. Contract W-31-109-eng-38. $0.20(OTS).

The reactivity of uranium, thorium, aluminum, copper, iron, magnesium, zirconium, and Fluorothene with bromine trifluoride, bromine pentafluoride, chlorine trifluoride, and fluorine was investigated at temperatures ranging from 25 to 410°C. The reactivity of platinum with bromine trifluoride was also studied. (auth)

SELECTION OF OPTIMUM FLUORINATING AGENT FOR FUSED-SALT PROCESS. G. E. Goring. Dec. 26, 1956. Decl. Mar. 11, 1957. 21p. (ANL-WAR-SL-1140)

Qualitative consideration of flowsheets using BrF_3, BrF_3-BrF_5, BrF_5, and ClF_3 showed that BrF_3-BrF_5 would afford the most realistic comparison with elemental F_2. Then, using a plant capacity of 100 STR cores per year as a basis, an economic comparison between the F_2 and BrF_3-BrF_5 systems was made. It was shown that the F_2 system could effect a saving on the order of $90,000 per year in such a plant, due mainly to lower manpower requirements. Differences in capital charges between the two alternates would be relatively minor, and differences in chemicals and utilities costs would be negligible.

6222
PREPARATION, PROPERTIES AND REACTIONS OF BISMUTH PENTAFLUORIDE. Jack Fischer and Edgars Rudzitis (Argonne National Lab., Lemont, Ill.). J. Am. Chem. Soc. 81, 6375-7(1959) Dec. 20.

Bismuth pentafluoride was prepared by synthesis from bismuth and fluorine at 500°C. Its crystal structure, density of the solid and liquid, triple point temperature, and vapor pressure were determined and the latent heat of vaporization and Trouton constant were calculated. Various chemical reactions of bismuth pentafluoride, such as its reduction with hydrogen and fluorination reactions with various elements and compounds, were studied. Bismuth pentafluoride acts as a strong fluorinating agent. (auth)

FUSED SALTS AND LIQUID METALS 2.20

See also, this section,
ELECTROCHEMICAL (2.16),
and,
under PROCESS CHEMISTRY AND ENGINEERING,
FUSED SALTS AND LIQUID METALS (6.10),
SPECIAL PROCESSES--Fused Salt-Fluoride Volatility (6.17.11).

PROCESS FOR SEPARATING URANIUM FISSION PRODUCTS. F. H. Spedding, T. A. Butler, and I. B. Johns (to U. S. Atomic Energy Commission). U. S. Patent 2,877,109. Mar. 10, 1959.

The removal of fission products such as strontium, barium, cesium, rubidium, or iodine from neutron-irradiated uranium is described. Uranium halide or elemental halogen is added to melted irradiated uranium to convert the fission products to either more volatile compositions which vaporize from the melt or to higher melting point compositions which separate as solids.

486

REFINEMENT OF FISSILE METALS. J. E. Antill (to U. K. Atomic Energy Authority). British Patent 792,347. Nuclear Eng. 3, 466(1958) Oct.

The removal of all fission products from metallic fuel elements after irradiation in a nuclear reactor without converting the metal from the metallic stage is described. A charge of at least one non-metallic compound which is immiscible with the metal and has an affinity for fission products, is added in the bottom of a crucible under an ingot of irradiated metal

10241

DECONTAMINATION OF URANIUM. H. M. Feder and N. R. Chellew (to U. S. Atomic Energy Commission). U. S. Patent 2,822,260. Feb. 4, 1958.

This patent deals with the separation of rare earth and other fission products from neutron bombarded uranium. This is accomplished by melting the uranium in contact with either thorium oxide, magnesium oxide, aluminum oxide, beryllium oxide, or uranium dioxide. The melting is preferably carried out at from 1150° to 1400°C in an inert atmosphere, such as argon or helium. During this treatment a scale of uranium dioxide forms on the uranium which contains most of the fission products.

2370 ORNL-2749

Oak Ridge National Lab., Tenn.

SOLUBILITY RELATIONS AMONG RARE-EARTH FLUORIDES IN SELECTED MOLTEN FLUORIDE SOLVENTS. W. T. Ward, R. A. Strehlow, W. R. Grimes, and G. M. Watson. Nov. 16, 1959. 14p. Contract W-7405-eng-26. OTS.

Solubility measurements of rare-earth and yttrium fluorides were made in various solvents containing zirconium or beryllium fluoride with certain alkali-metal fluorides, and in some cases uranium fluoride, present. Tests were performed which pertain to the development of a method of removal of rare earth fluoride nuclear poisons from certain mixtures of interest to the Molten Salt Power Reactor Program. The method is shown to be effective in several concentration ranges. (auth)

1485

ELECTROMIGRATION OF RADIOACTIVE IONS IN FUSED SALTS. APPLICATION TO THE SEPARATION OF ISOTOPES. Presented at the International Conference on Radioisotopes in Scientific Research, Sept. 9-20, 1957 at Paris. No. UNESCO/NS/RIC/214. H. J. Arnikar and M. Chemla. London, Pergamon Press, Ltd., 1957. 9p. (In French)

FUSED SALTS AND LIQUID METALS 2.20

7836 BNL-472
Brookhaven National Lab., Upton, N. Y.
NUCLEAR ENGINEERING DEPARTMENT PROGRESS REPORT [FOR] JANUARY 3–APRIL 30, 1957. F. Maslan, ed. 69p. $2.00(OTS).

As a part of LMFR fuel processing studies, salt-metal distribution coefficients were measured for Sm, Nd, U, and Zr in the presence of various Mg concentrations. A polarographic method was developed for analyzing dilute molten salt solutions. Molten salt corrosion loop status is reviewed. Additional data were obtained on erosion, corrosion, and mass transfer in circulating bismuth, bismuth alloy, and bismuth alloy slurry systems. The solubilities of a number of fission products in liquid bismuth were determined. An electrolytic method was developed for forming thorium bismuthide dispersions. Results are given from studies of uranium dissolution in bromine trifluoride. Radiation induced graft copolymerization was also investigated. Isotope separation and purification problems are reviewed. (For preceding period see BNL-434.) (D.E.B.)

Process for Fission-product Removal from Uranium-bismuth Reactor Fuels by Use of Fused-salt Extraction, O.E.DWYER. Am Inst Chem Engrs—J 2, 2, June 1956 p 163-8.

For power breeder thermal reactor, high neutron economy calls for low concentrations of fission products in fuel which are high neutron capturers; roughly 45% by weight of fission products can be continuously removed from fuel by salt extraction with alkaki and alkaline-earth fused-salt mixtures; products contain highly "poisonous" rare earths; process design considerations.

7677 ISC-607(Del.)
Ames Lab., Ames, Iowa.
QUARTERLY SUMMARY RESEARCH REPORT IN METALLURGY FOR JANUARY, FEBRUARY, MARCH 1955. Oct. 21, 1955. ~~Decl. Feb.~~ 26, 1957. 37p. Contract W-7405-eng-82. $0.40(OTS).

Studies on the separation of Nb from Ti, Hf from Zr, and Mg from Ca by sublimation and metals from Cr–U eutecti by liquid metal extraction were continued. Methods for the preparation of $ThCl_4$, YF_3, V, Ta, Nb, Th, and Y are presented. A study of the following alloys is reported: U–Zr, Th–Zr, Th–Hf, Th–C, Nb–U, Ta–Zr, Zr–Zn, Ta–V, and Nb–Zn. Corrosion of refractory and coated metals by liquid metals, carbides by molten U, hot-press bonding of Al to other metals, thermal cycling of metals through their transformation temperatures, the structure of Ge–Zr compounds, and corrosion of H_2SO_4 treated Zr and zircaloy in 300°C water were investigated. (J.E.D.)

10772 NAA-SR-1361
North American Aviation, Inc., Downey, Calif.
PYROCHEMICAL SEPARATION METHODS: III. THE REMOVAL OF FISSION PRODUCTS FROM MOLTEN, IRRADIATED URANIUM BY SOLID OXIDES. Albert M. Saul. Sept. 1, 1955. Decl. Jan. 12, 1956. 22p. Contract AT-11-1-Gen-8. $0.20(OTS).

Spent uranium fuel was heated in UO_2 and ZrO_2 crucibles at 1400°C and the resultant fission product extraction studied. Results indicate that ~99% of the rare earths, Sr, and Cs, and that 5 to 30% of the Pu are removed by this technique. (C.W.H.)

7546 NAA-SR-1397
North American Aviation, Inc., Downey, Calif.
SEPARATIONS CHEMISTRY QUARTERLY PROGRESS REPORT FOR JANUARY–MARCH 1955. E. E. Motta, David W. Bareis, Daniel Cubicciotti, and Archie G. Buyers, eds. Oct. 15, 1955. Decl. Feb. 27, 1957. 39p. Contract AT-11-1-GEN-8. $0.40(OTS).

Experiments with U fuel have demonstrated that Ce, rare earths, Sr, Cs, Te, and Pu are efficiently removed by vaporization at 1730° to 1775°C. Treated uranium contained only negligible traces of fission products as well as 24% Pu. Oxide scavenging of U fuel has demonstrated Cs and rare earth removal to the extent of 97 to 99% with slight Pu decontamination. Laboratory scale equilibration of molten U and Mg both in batch and recycling processes has removed

50 to 96% Pu. Addition of Sn, Li, or Fe had little or no effect upon Pu distribution. Small-scale preliminary distribution data have indicated that Pu can be extracted from spent U and reduced into fresh U using molten UF_4 as transfer medium. Urania crucibles have proven more effective as oxide scavenging agents than formation of oxide skins. Ninety-nine % Sr, Cs, rare earths, and Ce were removed by UO_2 crucible scavenging. Pu and Ru remained in the U fuel. Te was volatilized. Urania and alumina crucibles were found more suitable than zirconium nitride and titanium boride for containing molten Th. Carbide scavenging of Th–U alloy has partially removed Cs, Sr, and Te. Ru and Pa remained in the alloy. Cs and Sr were completely volatilized from Th–U alloy at 1850°C. Partial decontamination of Ce and rare earths was achieved. Pa, Ru, and Zr are not removed to any great extent. The de Boer-Van Arkel iodide process has been applied to irradiated Th–U alloy. An equilibration at 1150°C of Th–U–Mn alloy with ThF_4 has been carried out. Apparatus for arc zone melting has been developed and applied to zone melting of irradiated Th–U alloy. This resulted in complete removal of Sr by volatilization. (auth)

7345 BNL-3337
Columbia Univ., New York.
SOLUBILITY AND STRIPPING OF RARE GASES IN MOLTEN METALS. Final Report. June 30, 1955. 16p. For Brookhaven National Lab. Subcontract S-229. (CU-4-56-BNL-S229-Ch.E.) $3.30(ph OTS); $2.40(mf OTS).

The status of the work on solubility and stripping of xenon in molten bismuth at the end of the subcontract period is described. The experimental procedures have been improved to the point where they are entirely reliable. The results show the solubility of xenon in bismuth at 492°C to be 8×10^{-7} atom fraction at atmospheric pressure. Various theoretical predictions of the solubility range from 100 times this result to 10^{-17} times this result, are evidently entirely useless for obtaining reliable values. (auth)

11662 KLX-1739
Vitro Labs., West Orange, N. J.
HOMOGENEOUS REACTOR FUEL REPROCESSING BY CaF_2 ADSORPTION OF RARE EARTHS. JOB 1087. Dec. 31, 1954. Decl. Mar. 22, 1957. 30p. For Oak Ridge National Lab. Contract W-7405-eng-26, Subcontract 535. $0.35 (OTS).

It was found that contacting simulated reactor fuels with a packed bed containing CaF_2 would selectively remove mixed rare earths added to the feed solution in amounts which correspond to their expected concentration under reactor conditions. Such a process applied to the entire fuel charge of a homogeneous thermal breeder reactor would greatly enhance the neutron economy making possible a high breeding gain. Studies show that the CaF_2 functions by contributing fluoride to the solution, thereby precipitating rare earth fluorides which deposit in the solid bed. Optimum operating conditions for the process are discussed. (auth)

2901 TID-10021
North American Aviation, Inc., Downey, Calif.
DISSOLUTION AND DISTRIBUTION BY LIQUID SODIUM OF ACTIVATED TYPE 347 STAINLESS STEEL. A. M. Saul. Mar. 15, 1954. Decl. Mar. 19, 1957. 26p. Contract AT-11-1-GEN-8. (NAA-SR-284). $0.30(OTS).

The distribution by Na of the radioactive elements of Type 347 stainless steel was studied under dynamic conditions using convection-diffusion capsules operating between 300 and 700°C. The nuclides identified as depositing on the initially inactive walls of these capsules are Ta^{182}, Fe^{59}, Co^{60}, Cr^{51}, and Mn^{54}. Deposition of these activities does not seem to be a function of capsule wall temperature alone. It was found that the presence of O_2 greatly accelerates the transfer of activity. (auth)

5093 AECD-3877
Brookhaven National Lab., Upton, N. Y.
INTERIM REPORT OF THE FUEL PROCESSING GROUP. D. W. Bareis. Jan. 15, 1952. Decl. Dec. 12, 1955. 13p. $3.30(ph OTS); $2.40(mf OTS).

Included are results of studies of the rare earth distribution in bismuth–fused chloride melts, corrosion by bismuth–uranium and fused chloride systems and studies of fused chloride behavior. (B.J.H.)

FUSED SALTS AND LIQUID METALS 2.20

7292 A/CONF.15/P/1270
ETUDE D'UN ELEMENT DE CASCADE POUR LA SEPARATION DES ISOTOPES DU LITHIUM. (Study of a Cascade Element for the Separation of Isotopes of Lithium). Vallet, Kepes, Beaufils, and Belilowsky (Compagnie, Saint Gobain, France). 6p.

A method, based on the counter-current electromigration of isotopes in a molten medium, is given for the separation of lithium isotopes. The apparatus used consists of two sections, one for the anode and the other for the cathode, the two sections being connected by a horizontal porous diaphragm. The apparatus itself is pyrex or steatite NHF. The anode is of platinum, and the cathode is either aluminum or stainless steel. Molten lithium nitrate was used in the experiments, and fuming nitric acid was used as the regenerating agent. Some experimental results are given. (J.S.R.)

147 NAA-SR-1997
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
SEPARATIONS CHEMISTRY QUARTERLY PROGRESS REPORT [FOR] JANUARY–MARCH 1957. G. E. Brand, A. G. Buyers, W. J. Gardner, and E. E. Motta. Sept. 30, 1957. 25p. Contract AT-11-1-GEN-8. $0.75(OTS).

Two multikilogram scale remotely operated experiments using irradiated and natural U were conducted to study fission product removal by oxide drossing. Analytical results are not yet available. The diffusion coefficient of Ce in molten U was found to be 1×10^{-4} cm^2/sec at 1200°C. A series of nonconsumable electrode arc melting experiments using Th–U alloys has been completed showing that Pa and U can be evaporated at temperatures over 2000°C. Thorium was electrolyzed from molten salt baths by using an Fe cathode and a molten Zn anode. A theoretical equation was derived relating the decontamination factor to the standard electrode potentials of Th and other elements. (auth)

19980 ANL-6017
Argonne National Lab., Lemont, Ill.
EXTRACTION OF URANIUM, MAGNESIUM, ZIRCONIUM, AND CERIUM FROM BISMUTH WITH A FUSED FLUORIDE SALT MIXTURE. Max D. Adams, Jack Fischer, Robert J. Meyer, and Norman D. Phillips. June 1959. 19p. $0.75(OTS).

The extraction of uranium, magnesium, cerium, zirconium, and niobium from bismuth with a molten mixture of sodium fluoride and zirconium fluoride was demonstrated. Comparative rates of extraction were obtained. The effects of high concentrations of magnesium and of hydrogen fluoride sparging on the extraction process were investigated. Tracer studies demonstrated that exchange occurs between zirconium dissolved in the bismuth and zirconium in the fused salt. The applicability of the fused fluoride extraction step to the processing of the "Liquid Metal Fuel Reactor" solution fuel is discussed. (auth)

GADOLINIUM 2.21

15110
SEPARATION OF GADOLINIUM FROM ^{235}U FISSION PRODUCT RARE EARTHS. Aviezer Stevan Kertes (Hebrew Univ., Jerusalem). J. Inorg. & Nuclear Chem. 10, 161-4(1959) Apr.

A procedure is described for the separation of micro quantities of Gd from other natural uranium fission product rare earths. (W.L.H.)

16741 AECU-4212
Los Alamos Scientific Lab., N. Mex.
SEPARATION OF RARE EARTHS AT AMALGAM CATHODES. III. THE SEPARATION OF SAMARIUM FROM GADOLINIUM. E. I. Onstott. [1955]. 14p. Contract [W-7405-eng-36]. $3.30(ph), $2.40(mf) OTS.

Samarium is efficiently separated from gadolinium by electrolysis of the citrate complexes at a lithium amalgam cathode. Under optimum conditions, about 99% of the samarium is electrolyzed while less than 10% of the gadolinium is electrolyzed. There is also a preferential electrolysis of gadolinium over dyprosium. Data were obtained which show how the electrolysis is dependent on the cathode potential and the pH of the electrolyte. (auth)

INDIUM 2.22

RADIOCHEMICAL SEPARATIONS OF INDIUM. D. N. Sunderman, I. B. Ackermann, and W. W. Meinke (Univ. of Michigan, Ann Arbor). Anal. Chem. 31, 40-4(1959) Jan.

The radiochemical separation of indium by sulfide precipitation, solvent extraction of the bromide with diethyl ether, extraction with thenoyl trifluoroacetone and anion exchange in hydrochloric acid solution has been critically evaluated. Comparison of the efficiency of separation from 15 representative radioactive tracers showed that the sulfide precipitation lacked specificity as a decontamination step. Its primary utility is for the final preparation of counting plates or as a step preliminary to the determination of carrier yield by hydrous oxide precipitation. Ether extraction of the bromide gave decontamination factors as high as 10^4 for many dissimilar elements when conditions were well standardized. Thenoyltrifluoroacetone extractions gave decontaminations of 100 to 1000 for most elements. The anion exchange technique, when operated far from equilibrium with a short column, gave decontamination factors of about 10^3 for many elements with a procedure that requires 1 hour. (auth)

5274

CARRIER-FREE SEPARATION METHOD FOR RADIOACTIVE ISOTOPES. VII. SEPARATION BY MEANS OF ELECTRIC FIELD OF RADIOACTIVE In^{115m}, PRODUCED BY β DECAY OF Cd^{115}. Z. V. Pastukhova and N. P. Rudenko. Radiokhimiya 1, 273-6(1959). (In Russian)

A separation of In^{115m} from neutron-irradiated cadmium is achieved by collecting the recoil atoms by high-intensity electric field. (R.V.J.)

5270

CARRIER-FREE SEPARATION METHOD FOR RADIOACTIVE ISOTOPES. V. INDIUM AND CADMIUM BENZOYLACETONATES AND METHOD OF EXTRACTION SEPARATION OF RADIOACTIVE ISOTOPES OF INDIUM BY BENZOYLACETONE. N. P. Rudenko and I. Story. Radiokhimiya 1, 52-9(1959). (In Russian)

The stability constants of indium and cadmium benzoylacetonates were determined, and a carrier-free method for separating radioactive indium from irradiated cadmium is suggested. (R.V.J.)

IODINE 2.23

See also, under FISSIONABLE MATERIAL--RECOVERY, HEAD-END TREATMENT--Off-Gas (3.01.06).

18728 CF-58-1-138

Oak Ridge National Lab., Tenn.

HRT MOCKUP IODINE REMOVAL AND RECOMBINER TESTS. P. H. Harley. Jan. 13, 1958. 12p. Contract [W-7405-eng-26]. $3.30(ph), $2.40(mf) OTS.

Tests have been run in the HRT core system mockup which demonstrate that iodine can be successfully removed from dry steam by a silver bed. Such a bed is recommended to prevent iodine poisoning of the HRT recombiner catalyst. An added advantage will be removal of I^{135} from circulation, whereby reducing neutron losses to Xe^{135}, a daughter. Four experiments were made with the silvered Alundum pellets during which experimental mass transfer coefficients were determined. At 110°C the experimental kg was 25% of the theoretical value, and at 150°C the kg was 52% of the theoretical. The experimental efficiencies were 68% and 97.8% of the theoretical efficiencies at the above temperatures. Increasing the gas temperature greatly improved the correlation of the theoretical and experimental data. Two iodine removal tests were made using silver-plated stainless steel wire mesh. These two tests gave higher removal efficiencies than the corresponding tests with the silvered Alundum rings. The metal support is preferred also because of its greater mechanical and chemical stability. In particular, leaching of Na_2O from Alundum rings was noted in the HRT. In a test of the stability of the silver-plated wire mesh, only 0.0025% of the silver was lost in a 650 hour run. During mockup tests without a silver bed, iodine poisoning lowered the recombiner efficiency from 99.97% to 98% at the HRT design conditions. Increasing the recombiner temperature to 650°C was found to be effective in removing iodine poison from the platinum catalyst. (auth)

576 JENER-52

Joint Establishment for Nuclear Energy Research, Kjeller, Norway.

A SIMPLE APPARATUS FOR PRODUCTION OF RADIOACTIVE IODINE-131 BY DRY DISTILLATION FROM PILE-IRRADIATED TELLURIUM DIOXIDE. Kjell Taugbøl and J. B. Dahl. Sept. 1957. 8p.

IODINE 2.23

HOMOGENEOUS REACTOR FUEL REPROCESSING QUARTERLY PROGRESS REPORT FOR JULY 1–SEPTEMBER 30, 1955. Harold F. Reichard, John D. McAdoo, Stanley J. Klach, Gloria K. Koenig, and Paul E. Smith. Nov. 15, 1955. Decl. Mar. 25, 1957. 21p. (KLX-10012)

The equilibrium distribution of elemental I_2 was studied between vapor and liquid phases in a simulated homogeneous reactor fuel solution (pH = 2.1). A distribution coefficient, K, defined as the ratio of mol fraction I_2 in vapor to mol fraction I_2 in liquid, was found to be ~7 over a wide range of concentrations and at 280 and 330°C. In the absence of the $UO_2SO_4 - H_2SO_4 - CuSO_4$ solutes, K was found to be on the order of 0.25 with little variation between pH 3.8 and 9.9. Calculations were made to determine the feasibility of using countercurrent inert gas stripping of fuel solution in packed columns. The results indicate that an infinite number of transfer units would be required to effect a separation of >3.5 (concentration of I_2 inlet/concentration of I_2 outlet). As an alternative to using packed columns for I_2 stripping, a liquid-jet ejector for inert gas stripping of fuel solution is proposed.

4357 AERE-C/M-186
Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.
THE REACTION OF FISSION PRODUCT IODINE WITH SOLVENTS. N. J. Keen and K. Alcock. Oct. 1953. Decl. Nov. 26, 1956. 10p.

Iodine combines to a small extent with butex, tributyl phosphate, and kerosene, or more probably, with some impurities contained in the solvents. The rate of extraction of I_2 from these solvents has been determined and it has been shown that cold NaOH will remove all the free I_2 in 5 minutes, but the residual combined I_2 is not extracted even under much more drastic conditions. (auth)

19855 NP-tr-289
THE ABSORPTION OF IODINE VAPOUR BY ACTIVATED CARBON AND SILICA GEL. P. Demougin. Translated by J. B. Sykes (U.K.A.E.A. Atomic Energy Research Establishment from Compt. rend. 200, 662-5 (1935). 5p. $1.80(ph), $1.80(mf) JCL.

An investigation was made to determine whether there is a discontinuity in the adsorption of iodine vapor on passing from temperature at which iodine is solid to those at which it is liquid. Various activated carbons and silica gel were used as the adsorbent. Data are presented on the quantity iodine adsorbed (mg per g) above and below the melting point for activated carbon and silica gel. (W.L.H.)

12238 ARSC-28(Del.)
Air Reduction Sales Co. Research Labs., Murray Hill, N. J.
THE REMOVAL OF IODINE FROM GAS STREAMS BY REACTION WITH SILVER IN PACKED TOWERS. R. McNabney and A. M. Lyon. Aug. 26, 1949. Decl. with deletions Mar. 24, 1959. 31p. Contract AT-30-3-GEN-2. $9.30(ph), $3.60(mf) OTS.

A process was developed for the removal of iodine alone in the presence of the various other constituents of pile dissolver off-gases. The principal feature of the process is the use of a column packed with Berl saddles coated with silver nitrate or silver. Experiments were conducted using a column with a packed section 17 in. long by 2 in. diameter through which was passed a stream of air at 2 cfm containing NO_2, water vapor, and iodine. This tower operating on this gas stream is equivalent to a 6-foot plant scale tower operating on Hanford off-gases. (auth)

UTILIZATION OF ISOTOPIC EXCHANGE FOR RADIOCHEMICAL SEPARATIONS. D.N. Sunderman and W.W. Meinke. May 6, 1955. 10p. (AECU-3846; M-5682).

CHEMICAL SEPARATIONS. D. N. Sunderman and W. W. Meinke. May 6, 1955. 10p. (M-5682). $1.80 (ph OTS); $1.80(mf OTS).

A rapid, high decontamination, single step method for separation of trace quantities of radioactive species such as silver and iodine has been developed. This method depends upon the rapid exchange between the ion and a thin film of solid silver halide supported on a platinum gauze electrode. High yields of the radioactivity are obtained in a few minutes. Effects on the yield of time, temperature, amount of precipitate, foreign salts, etc., have been studied. Decontaminations (some as high as 10^6) have been determined with tracers of 16 typical elements. By utilizing columns with plates or beads of metal coated with such a precipitate, this method might take its place beside standard engineering operations such as distillation, ion exchange, etc., for trace separation of radioisotopes of a number of elements. (auth)

IODINE 2.23

12699 CF-57-9-50
Oak Ridge National Lab., Tenn.
HRT IODINE REMOVAL BED. E. H. Gift. Sept. 10, 1957. 39p. Contract W-7405-eng-26. $6.30(ph OTS); $3.00 (mf OTS).

An iodine removal bed primarily for the purpose of preventing poisoning of the recombiner catalyst was designed for operation in the HRT. The bed consists of a 12-in.-ID, 36-in.-long cylinder filled with ½ in. silvered alundum Raschig rings. During operation, the steam gas mixture entering the bed is dried by a steam coil preceding the bed. During shutdown decay heat must be removed for the first 10 hr by a combination of steam flow from the dump tanks and internal cooling of the bed by water jacketed annuli. After about 10 hr the cooling capacity of the water jacketed annuli will be sufficient to remove the heat. A sketch of the bed is shown, and reference drawings are given. (auth)

11502
ABSORPTION OF IODINE VAPOR. Ralph McNabney (to U. S. Atomic Energy Commission). U. S. Patent 2,795,482. June 11, 1957.

The recovery of I_2 from gaseous mixtures containing relatively small amounts of elemental iodine in vapor form is described. The method consists in preparing an inert carrier having silver-bearing surface areas and passing the mixed gas over the carrier under conditions which cause the elemental iodine to react with the Ag to produce AgI. Preferred results are obtained by using a layer of a Ag salt such as $AgNO_3$ on the carrier material. (auth)

5335 KLX-10067
Vitro Labs., West Orange, N. J.
HOMOGENEOUS REACTOR FUEL REPROCESSING. Quarterly Progress Report [for] January 1–March 31, 1957. Vitro Job 1087. Robert A. Keeler, Charles J. Anderson, Stanley J. Klach, and Gloria K. Koenig. Apr. 31, 1957. Decl. Jan. 13, 1959. 31p. For Oak Ridge National Lab. Contract W-7405-eng-26, Subcontract No. 535. $4.80(ph OTS); $2.70(mf OTS).

An equilibrium study of I_2 between Pt pellets and H_2–O_2–steam at 350°C is described. The solubility of Kr and O_2 in homogeneous reactor fuel solution was investigated. The study of the chemical processing of underflow from the HR hydroclones for recovery of U and water continued. (T.R.H.)

80
MOLECULAR SIEVES ADSORB IODINE-131 FROM AIR. Morris A. Wahlgren and W. Wayne Meinke (Univ. of Michigan, Ann Arbor). Nucleonics 15, No. 9, 156, 158, 160(1957) Sept.

19032 HW-50259(Del.)
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
THE REMOVAL OF IODINE FROM DISSOLVER OFF-GAS BY CAUSTIC SCRUBBING. K. V. Seyfrit. May 20, 1957. Decl. with deletions July 7, 1959. 6p. Contract W-31-109-Eng-52. $1.80(ph), $1.80(mf) OTS.

Revised limits for radioactive iodine emission have made necessary the construction of supplementary iodine removal facilities for the Purex plant. An installation consisting of an acid absorber and caustic scrubber was found to have an efficiency greater than 99.85% under certain conditions. (W.L.H.)

7967 HW-47676
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
REMOVAL OF IODINE-131 FROM DISSOLVER OFF-GAS STREAMS BY ISOTOPIC EXCHANGE. E. D. McClanahan, Jr. Nov. 15, 1956. 19p. Contract W-31-109-Eng-52. $0.20(OTS).

Experiments were performed which indicate that iodine atoms in plant off-gas streams exchange with those in solid AgI in the temperature range 250 to 350°C. The exchange is fast enough to make it of practical use for removing I^{131} at concentrations as low as 10^{-7} gm/ft^3. An AgI reactor would best be employed as a back-up facility for an $AgNO_3$ reactor. The combined efficiency of the two could give decontamination factors in excess of 10^4. (auth)

HOMOGENEOUS REACTOR FUEL REPROCESSING. Quarterly Progress Report [for] January 1–March 31, 1956. Dept. of Chemical Research and Development. Vitro Job 1087. Harold F. Reichard, John D. McAdoo, Stanley J. Klach, Gloria K. Koenig, and Paul E. Smith. Apr. 30, 1956. Decl. Feb. 26, 1957. 25p. For Oak Ridge National Lab. (KLX-10026)

Studies were continued on the rapid removal of I_2 from reactor core solutions by scrubbing and on the dissolution of ThO_2 blanket slurry solids by HF–HNO_3 solutions prior to Thorex processing.

IODINE 2.23

HOMOGENEOUS REACTOR FUEL REPROCESSING. Quarterly Progress Report for July 1–September 30, 1956. Vitro Job 1087. Harold F. Reichard, John D. McAdoo, Charles J. Anderson, Stanley J. Klach, Gloria K. Koenig, and Paul E. Smith. Oct. 31, 1956. Decl. Mar. 4, 1957. 26p. (KLX-10045)

Further studies are reported on the behavior of I_2 in aqueous homogeneous reactor systems. Gas-stripping of I_2 from a circulating simulated HR fuel solution stream (O_2 overpressure) at 230°C and 850 to 960 psi was studied. I_2 vapor-liquid equilibria, I_2 adsorption from off-gases in the low-pressure recombiner catalyst bed, and the use of CuO as solid sorber in a high-pressure I_2 removal system were also investigated.

11638 KLX-10034
Vitro Labs., West Orange, N. J.
HOMOGENEOUS REACTOR FUEL REPROCESSING. Quarterly Progress Report [for] April 1–June 30, 1956. Vitro Job 1087. Harold F. Reichard, John D. McAdoo, Stanley J. Klach, Gloria K. Koenig, and Paul E. Smith. July 31, 1956. Decl. Mar. 29, 1957. 14p. For Oak Ridge National Lab. Contract W-7405-eng-26, Subcontract No. 535. $0.30(OTS).

The behavior of volatile fission products in aqueous homogeneous reactor core solution was studied. Particular attention is given to the chemistry of I_2, with the specific objective of removing I_2 rapidly from the fuel as a means of controlling Xe^{135} poisoning. Feasibility of high-pressure oxygen stripping of I_2 with an ejector is being studied as a means of implementing this process. (auth)

HOMOGENEOUS REACTOR FUEL REPROCESSING QUARTERLY PROGRESS REPORT [FOR] JULY 1–SEPTEMBER 30, 1955. Job 1087. Harold F. Reichard, John D. McAdoo, Stanley J. Klach, Gloria K. Koenig, and Paul E. Smith. Nov. 15, 1955. Decl. Mar. 25, 1957. 21p. (KLX-10012)

The equilibrium distribution of I_2 was studied between vapor and liquid phases in a simulated homogeneous reactor fuel solution. Calculations were made to determine the feasibility of using countercurrent inert gas stripping of fuel solution in packed columns.

11637 KLX-10020
Vitro Labs., West Orange, N. J.
HOMOGENEOUS REACTOR FUEL REPROCESSING. Quarterly Progress Report [for] October 1–December 31, 1955. Dept. of Chemical Research and Development. Harold F. Reichard, John D. McAdoo, Stanley J. Klach, Gloria K. Koenig, and Paul E. Smith. Jan. 31, 1956. Decl. Apr. 2, 1957. 27p. For Oak Ridge National Lab. Contract W-7405-eng-26, Subcontract No. 535. $0.35 (OTS).

A gas stripping process for short-term I_2 removal is being studied as a means of Xe^{135} poison control in an aqueous homogeneous reactor. A liquid jet ejector is being developed to serve the purpose of a single-stage contactor for pumped fuel solution and stripping gas and a high-capacity low-head compressor for circulating the strip gas through an iodine absorption cycle. Laboratory studies were continued on batch scrubbing of iodine and acid dissolution of ThO_2. (For preceding period see KLX-10012.) (C.W.H.)

13646 CF-56-2-81
Oak Ridge National Lab., Tenn.
REMOVAL OF IODINE FROM HOMOGENEOUS REACTORS. D. E. Ferguson. Feb. 16, 1956. ~~Decl. Mar.~~ 16, 1957. 29p. Contract [W-7405-eng-26]. $4.80(ph OTS); $2.70(mf OTS).

Two suggested methods look both feasible and attractive for the removal of iodine from the fuel of a two-region reactor. The first consists of stripping I from the fuel with O_2 and D_2O vapor, scrubbing iodine from the gas with about 4 gpm D_2O, and finally letting down this small stream of D_2O for removal and storage of the I. For a 5 ft core operating at 360 Mw, this method involves circulating a calculated 275 gpm of fuel solution countercurrent to 4.2 lb moles/min of O_2-D_2O gas to maintain a Xe^{135} poison level of 0.5%. The second method consists of a radiolytic gas let-down system similar to that designed for the HRT, which would take advantage of the stripping of both I and the rare gases by allowing the radiolytic gas to form. This method would require a gas let-down rate of 2600 ml/sec with a liquid let-down rate of about 10 gpm to maintain the Xe^{135} poison level of the TBR at 0.5%. (auth)

IONIZED BEAMS 2.24

389
SEPARATION OF ISOTOPES WHEN AN ATOMIC BEAM PASSES THROUGH IONIZED SPACE. K. D. Sinel'nikov, B. G. Safronov, et. al. (Physico-Technical Inst., Acad. of Sciences, U.S.S.R.). Doklady Akad. Nauk S.S.S.R. 115, 80-3(1957) July 1. (In Russian)

Theoretical analysis indicates the possibility of isotopic separation when an atomic beam consisting of mixed isotopes passes through the space in which it undergoes an electron bombardment. To detect this effect, it was necessary to use a triode monometric lamp which permitted on one hand the ionization of the passing beam and on the other the catching and binding of the new formed ions. Results of measurements and calculations of enrichment are included. (R.V.J.)

5422 NP-6215
ARC INITIATED DISCHARGE IN MAGNETIC FIELD IN HIGH VACUUM. II. MAGNETO-IONIC EXPANDER TYPE OF DISCHARGE. Joseph Slepian. Aug. 1956. 18p.

The theory of the magneto-ionic isotope separator is discussed, and the equations describing the magnetic and electrostatic forces at various locations in the separator are developed. (D.E.B.)

5421 NP-6214
ARC INITIATED DISCHARGE IN MAGNETIC FIELD IN HIGH VACUUM. I. IONIC CENTRIFUGE TYPE OF DISCHARGE. Joseph Slepian. June 1956. 15p.

An ionic centrifuge type of discharge was investigated as a possible method of isotope separation. This type of discharge from a central electrode ran to an insulated cylindrical electrode which floated approximately at the Larmor potential and took half the yield of cations from the arc. The remaining cations went to end plates having potentials exceeding the Larmor potential. The discharge shows no space charge limitations, however, its use in isotope separation did not appear promising since its enrichment at the end plates was less than m/2m. (D.E.B.)

ION EXCHANGE 2.25

ADSORPTION METHOD FOR SEPARATING METAL CATIONS. E. R. Tompkins and G. W. Parker (to U. S. Atomic Energy Commission). U. S. Patent 2,877,093. Mar. 10, 1959.

An improved method is presented for the chromatographic separation of fission products wherein a substantial reduction in liquid volume is obtained. The process consists in contacting a solution containing fission products with a body of ion-exchange adsorbent to effect adsorption of fission product cations. The loaded exchange resin is then contacted with a small volume of a carboxylic acid eluant, thereby recovering the fission products. The fission product carrying eluate is acidified without increasing its volume to the volume of the original solution, and the acidified eluate is then used as a feed solution for a smaller body of ion-exchange resin effecting readsorption of the fission product cations.

13829
ION-EXCHANGE SEPARATION OF FISSION PRODUCTS. Eiiti Minami, Masatake Honda, and Yukiyoshi Sasaki (Univ. of Tokyo). Bull. Chem. Soc. Japan 31, 372-7(1958) Apr.

Studies were made to find a systematic separation method for fission products, taking into account the minor constituents distributed in the "trough" region of the fission yield-mass curve. The ion exchange behavior of the individual elements was first studied. A possible ion exchange separation process for a fission product mixture is given. (J.S.R.)

9540
REMOVAL OF MATERIAL FROM PROCESSING TANKS. D. S. Webster (to U. S. Atomic Energy Commission). U. S. Patent 2,793,753. May 28, 1957.

A method for remote control removal of radioactive fission products from solutions is given. The solution is run over an ion exchange resin whereby the fission products are adsorbed. The adsorbate is first treated with an eluting agent specific to Pu, whereby the Pu is desorbed and separated, while the fission products remain on the resin. The resin is then removed from the containing vessel by means of a gas or vapor lift, a fresh supply of resin is introduced, and the process repeated. (auth)

ION EXCHANGE 2.25

SEPARATION OF TITANIUM FROM ACCOMPANYING ELEMENTS BY ION-EXCHANGE CHROMATOGRAPHY. II. SEPARATION OF Ti AND Cr. I. P. Alimarin, T. A. Belyavskaya, and L. A. Bazhanova (Lomonosov Moscow State Univ.). Zhur. Analit. Fiz. 12, 377-80(1957) May-June. (In Russian)

A method has been developed for the quantitative chromatographic separation of Ti and Cr at the ratios Ti : Cr from 1 : 100 to 10.00 : 1 with 0.5% solution of complexone III. (tr-auth)

1484

AN APPROACH TO THE PRODUCTION OF PHOSPHOROUS-33 IN MILLICURIE QUANTITIES. Presented at the International Conference on Radioisotopes in Scientific Research, Sept. 9-20, 1957 at Paris. No. UNESCO/NS/RIC/12. E. G. T. Westermark, I. G. A. Fogelstrom-Fineman, and S. R. Forberg. London, Pergamon Press, Ltd., 1957. 13p.

The nuclear properties of P^{33} (25 days' half-life) are critically reviewed. At present the possibilities of production of P^{33} free from P^{32} are very limited. This situation is discussed with the following conclusion: Enrichment of S^{33} in the target material plus subsequent reactor neutron irradiation would facilitate a production in millicurie or larger quantities. Isotope enrichment methods for the heavy sulfur isotopes are therefore discussed. An ion exchange method is selected and its characteristic parameters, separation factor (K) and theoretical equivalent plate height (HETP) are discussed. A laboratory program is outlined which might lead to the production of P^{33} in sufficient quantities and purity. (auth)

6875

ISOTOPIC EFFECT IN THE CAPTURE OF NEUTRONS (Br^{80} AND Br^{82}). D. Apers, P. Capron, and L. Gilly. J. chim. phys. 54, 314-16(1957) Apr. (In French)

Experiments made with iso C_3H_7Br, purified by passage through an alumina column and irradiated with slow neutrons, show a different chemical behavior of bromine isotopes 80 and 82. This difference is shown in the activity ratios of two isotopes in the liquid either passed or not passed through an alumina column. These results confirm previous results on isomerism. (tr-auth)

6302

THE SEPARATION OF THE LANTHANONS WITH THE AID OF ETHYLENEDIAMINE-TETRA-ACID ("ENTA ACID"). PART VI. ION-EXCHANGE STUDIES OF THE HEAVY AND MIDDLE LANTHANONS AND YTTRIUM. J. K. Marsh (Dyson Perrins Lab., Oxford). J. Chem. Soc. 978-82(1957) Mar.

Hot, shallow beds of fine sulphonated polystyrene cation exchanger are loaded with lanthanons and developed on a bed of mixed copper and hydrogen forms of the resin by elution with ammonium-buffered "enta acid." Good yields of purified heavy and middle lanthanons are obtained, but the separation of dysprosium from yttrium is exceptionally difficult. A crude load of 0.6 equivalent of lanthanon per cm^2 of column cross-section on a bed 60 cm deep was separated into ternary mixtures. These, re-run at 0.1 – 0.15 equiv/cm^2, were resolved satisfactorily on 45- or 60-cm beds (load vol/development vol. = 1) and recovered in solution of concentrations greater than 0.2 equiv/l. Intermediates between each pair of purified earths amounted to about 0.007 equiv/cm^2 or a 3 cm band on the developed column. (auth)

4763

RADIOCHEMICAL SEPARATIONS BY ION EXCHANGE. Kurt A. Kraus and Frederick Nelson (Oak Ridge National Lab., Tenn.). Ann. Rev. Nuclear Sci. 7, 31-46(1957).

1755 ISC-617

Ames Lab., Ames, Iowa.

BASIC PRINCIPLES INVOLVED IN THE MACRO-SEPARATION OF ADJACENT RARE EARTHS FROM EACH OTHER BY MEANS OF ION EXCHANGE. J. E. Powell and F. H. Spedding. Oct. 26, 1955. 28p. Contract W-7405-eng-82.

The separation of rare earth mixtures by ion exchange using ammonium ethylenediaminetetraacetate as an eluting agent and cupric ion as a retaining cation has been discussed in detail. Simple counter-current separation theory has been used to predict the minimum number of displacements of an adsorbed band that are necessary in order to separate the components of a binary mixture. It has been shown how the theory can be applied to even more complex systems and experimental data have been presented for some of the more difficultly separable groups of rare-earth species. (auth)

ION EXCHANGE 2.25

7183 AERE-C/R-2277
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
FISSION PRODUCT SEPARATION BY ION-EXCHANGE. F. Morgan and M. L. Sizeland. 1957. Date of MS. 1952. Decl. Apr. 1957. 19p. $0.54(BIS).

A remote-control apparatus has been built and operated for the separation and concentration of the major long-lived fission products by ion exchange: operating details and desirable improvements are given. Factors governing the ion exchange separation of the rare earths are discussed and illustrated. (auth)

3665 CEA-tr-X92
SÉPARATION DES PRODUITS DE FISSION PAR DES RÉSINES ÉCHANGEUSES D'IONS. (Separation of Fission Products by Ion Exchange Resins.) M. Honda, Y. Sasaki, and H. Natsume. Translated by Eiichi Hara from Bunseki Kagaku 4, 240-2(1955). 7p.

The ion exchange separation of fission products was studied. The classical method of ion exchange was modified only a little. Satisfactory results were obtained by using an ammonium chloride solution for the separation of the alkaline metals, an ammonium acetate solution for the separation of the rare earths, and EDTA for the separation of the alkaline earth metals. (J.S.R.)

6590 AERE-I/M-39
Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.
THE SEPARATION OF Mn^{54}, Co^{56}, Co^{58}, Zn^{65}, AND Nb^{95m} IN A CARRIER-FREE STATE BY THE USE OF ANION EXCHANGE RESIN. C. E. Mellish. Dec. 1955. 5p.

Techniques are outlined for the separation of the following isotopes from target materials using anion exchange resins in acid solution: Mn^{54} and Co^{56} from Fe, Co^{58} from Ni, Zn^{65} from Cu, and Nb^{95m} from Zr^{95}. (C.W.H.)

6581 RMI-284

ISOTOPE EXCHANGE 2.26

7704 CF-54-11-162
Oak Ridge National Lab., Tenn.
FRACTIONATION OF URANIUM ISOTOPES BY ION EXCHANGE. J. S. Drury and A. C. Rutenberg. Nov. 23, 1954. Decl. Feb. 14, 1957. 6p. Contract [W-7405-eng-26]. $1.80(ph OTS); $1.80(mf OTS).

An experiment was performed to determine the isotope fractionation obtained by passing a band of U through an ion exchange column. The conditions of the experiment were similar to those existing in the experiment described in ISC-475, except that an 11-in. band of U was passed through 64 in. of Cu resin. Very little enrichment resulted. (auth)

1590
ISOTOPE SEPARATION BY ION EXCHANGE. E. Glueckauf (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Am. Chem. Soc. 81, 5262-3(1959) Oct. 5.

The close analogy between ion exchange resins and concentrated aqueous solution is demonstrated by the equilibrium between a dilute and concentrated aqueous solutions of corresponding to that of the exchangers concerned. Supporting examples and data are given and it is noted that if this principle applies generally, the outlook for enriching isotopes of higher mass by pure ion exchange is dim. (J.R.D.)

172 ORNL-2852
Oak Ridge National Lab., Tenn.
ISOTOPE SEPARATION AND ISOTOPE EXCHANGE. A Bibliography with Abstracts. G. M. Begun. Oct. 28, 1959. 239p. Contract W-7405-eng-26. OTS.

The unclassified literature covering 2498 reports from 1907 through 1957 has been searched for isotopic exchange and isotopic separation reactions involving U and the lighter elements of the periodic chart through atomic number 30. From 1953 to 1957, all elements were included. Numerous references to isotope properties, isotopic ratios, and kinetic isotope effects were included. This is a complete revision of TID-3036 (Revised) issued June 4, 1954. An author index is included. (auth)

ISOTOPE EXCHANGE 2.26

THE MAGNITUDE OF ELECTRONIC ISOTOPE EFFECTS. R. E. Weston, Jr. (Brookhaven National Lab., Upton, N. Y.). Tetrahedron 6, 31-5(1959).

Secondary isotope effects, i.e., kinetic isotope effects in reactions where the bond to the labeled atom is not broken, are now being widely used for investigations of organic reaction mechanisms. In a recent paper, Halevi discussed secondary hydrogen isotope effects, and has suggested that there is an inductive contribution to such isotope effects. In particular, it is suggested that electron release from a C–D bond is more facile than from a C–H bond. The evidence cited by Halevi is examined, and the theoretical limitations on such an effect are estimated. (auth)

THE PROCEDURAL-TECHNICAL BASIS OF ISOTOPE SEPARATION BY HOT-COLD EXCHANGE. A. Schmidt (Österreichische Stickstoffwerke Aktiengesellschaft, Linz/Donau, Austria). Atompraxis 5, 94-8(1959). (In German)

The requirements of nuclear technology have made it necessary in recent years to separate the isotopes of various elements on an industrial scale. Since the chemical as well as the physical differences between such isotopes and their compounds are slight, their separation requires considerable technical effort. Chemical exchange, especially the dual-temperature process, has proved to be one of the best separation methods. The article gives a survey of this technique, which is not yet widely known. (auth)

EQUILIBRIUM CONSTANTS FOR BORON ISOTOPE EXCHANGE REACTIONS. Slobodan V. Ribnikar. Bull. Inst. Nuclear Sci. "Boris Kidrich" (Belgrade) 8, 31-41(1958) Mar.

The rate and magnitude of the boron isotope exchange reactions between boron trifluoride gas and its liquid compounds with ethyl ether, n-butyl ether, ethyl formate and water are investigated. The direction of the enrichment of B^{10} is found to be in the liquid phases, with equilibrium constants being between 1.025 and 1.031 at 20°C. (auth)

10383

ON THE LIMITS OF APPLICABILITY OF THE FIRST ORDER KINETIC EQUATION FOR ISOTOPIC EXCHANGE. Ya. M. Varshavskii and S. E. Vaisberg (Karpov Inst. of Physical Chemistry, Moscow). Zhur. Fiz. Khim. 32, 454-9(1958) Feb. (In Russian)

The deviation of isotopic-exchange reactions from first order has been examined on a bimolecular reaction as example. The maximum deviations of the practically possible distribution coefficient values have been calculated over the entire range of component and isotope concentrations. (tr-auth)

14609 A/CONF.15/P/722

Brookhaven National Lab., Upton, N. Y.

TEMPERATURE INDEPENDENT ISOTOPE EFFECTS IN CHEMICAL EXCHANGE EQUILIBRIA INVOLVING LINEAR MOLECULES. Jacob Bigeleisen. 11p. $0.50 (OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

The temperature independent factor of the equilibrium constant of an isotopic exchange reaction arises from the classical contribution to the quantum mechanical partition function. It consists of a symmetry number factor and a ratio of vibrational frequencies of the isotopic molecules. Only those vibrational frequencies whose Boltzmann arguments, $hc\omega/kT$, are greater than 2π can contribute to the temperature independent factor. For exchange reactions occurring above room temperature only stretching frequencies are to be included in the ratio of vibrational frequencies. In a linear molecule containing n atoms, the 3n-5 vibrations can be divided into n-1 stretching vibrations and n-2 doubly

10875 CEA-tr-R-589

LIMITES D'UTILISATION D'UNE EQUATION CINETIQUE DE PREMIER ORDRE POUR LES REACTIONS D'ECHANGE ISOTOPIQUE. (Limits of Utilization of a Kinetic Equation of the First Order for Isotopic Exchange Reactions.) Ya. M. Varshavskii and S. E. Vaisberg. Translated into French from Zhur. Fiz. Khim. 32, 454-9(1958). 14p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 10383.

ISOTOPE EXCHANGE 2.26

14697 A/CONF.15/P/719
Oak Ridge Gaseous Diffusion Plant, Tenn.
APPLICABILITY OF A SEPARATION PROCESS FOR LARGE-SCALE ISOTOPE PRODUCTION. S. A. Levin and E. Von Halle. 11p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

The considerations, presented in two parts, deal with isotope enrichment by irreversible chemical reactions. In the first part the necessary equations that quantitatively describe the process are developed. The performance of both a single separation state and of a cascade of stages connected in series are considered. The other part of the presentation deals with the design considerations necessary to evaluate a process. The applicability of irreversible chemical reactions to large-scale separation of isotopes is then evaluated by comparing costs for isotope separation in a cascade utilizing in one case irreversible chemical reactions and in the other case chemical exchange. The chemical exchange process was chosen as a standard of comparison because it has so far been the most attractive process in the case of light element. The evaluation shows that the irreversible chemical reaction process is severly handicapped because of its requirements for a reflux after each stage compared to a chemical exchange process which requires refluxing only at the two ends. It therefore appears that for large-scale separation of isotopes the irreversible chemical reaction process will not be competitive unless it has a relatively high separation factor compared with that of the corresponding chemical exchange process. For very small enrichments the costs would be more comparable. (auth)

7104
CALCULATION OF EXPERIMENTAL ISOTOPE EFFECTS FOR PSEUDO FIRST-ORDER IRREVERSIBLE REACTIONS. James Ying-peh Tong and Peter E. Yankwich (Univ. of Illinois, Urbana). J. Phys. Chem. 61, 540-3(1957) May.

Four exact equations are derived for the calculation of experimental isotope effects of systems of pseudo first-order irreversible reactions. The input data are either measured isotope ratios alone, or a combination of isotope ratios with the measured reaction coördinate. The advantages and disadvantages of these equations over those of the zero-time approximation method are discussed. (auth)

12519 CEA-tr-R-620
MÉCANISME DE LA MIGRATION DES RADIOISOTOPES FORMES LORS DE LA DESINTEGRATION α. (Mechanism of the Migration of Radioisotopes formed during α Disintegration.) V. I. Baranov, A. M. Babeshkin (Babechkine), and K. B. Zaborenko (Zavorenko). Translated into French from Zhur. Neorg. Khim. 3, 2200-9(1958). 28p. (Includes original, 11p.)

The laws governing the accumulation and distribution, in a solid body, of radioisotopes formed by alpha disintegration and the effect of the distribution on the transfer of the radioisotope into solution were studied. A mechanism of accumulation and distribution of recoil atoms in the solid phase is proposed. The effect of various factors on the transfer of radioisotopes from the solid phase to the liquid phase was investigated using radium isotopes as an example. The experimental results are in agreement with the mechanism proposed. (tr-auth)

ISOTOPIC EXCHANGE REACTIONS OF NEPTUNIUM IONS IN SOLUTION. V. THE Np(V) – Np(VI) EXCHANGE IN D_2O. J. C. Sullivan, Donald Cohen, and J. C. Hindman (Argonne National Lab., Lemont, Ill.). J. Am. Chem. Soc. 79, 3672-4(1957) July 20.

7097
INTEGRATED RATE EQUATIONS FOR ISOTOPIC EXCHANGE IN SIMPLE REVERSIBLE REACTIONS. Robert A. Alberty and Wilmer G. Miller (Univ. of Wisconsin, Madison). J. Chem. Phys. 26, 1231-7(1957) May.

The integrated rate equations are given for various mechanism by which three substances may be interconverted by first-order reactions. These equations are of special interest in the interpretation of isotopic exchange in the presence of an over-all chemical reaction. When certain rate constants in the mechanism are equal or have the same ratio as the ratio of concentrations of isotopic species in the reaction medium, considerable simplification of the integrated rate equation occurs. (auth)

7105
STUDY OF THE ISOTOPIC EXCHANGE BETWEEN Te(IV) AND Te(VI) IN ACID SOLUTION. M. W. Hanson and T. C. Hoering (Univ. of Arkansas, Fayetteville). J. Phys. Chem. 61, 699(1957) May.

ISOTOPE EXCHANGE 2.26

9555
ISOTOPE EXCHANGE PROCESS. R. W. Woodard (to U. S. Atomic Energy Commission). U. S. Patent 2,787,587. Apr. 2, 1957.

A method is given for obtaining the isotopic concentration of U by effecting isotopic exchange between ionic uranium maintained in different valence states. Aqueous solutions of uranous and uranyl ion in the form of strong mineral acid salts are maintained at a pH of approximately 2.0. The heavier isotope concentrates in the lower valent state and the lighter isotope in the higher valent state. The single stage enrichment factor is sufficiently great to make feasible isolation of a single isotope by a multistage operation. (auth)

KINETICS OF COMPETITIVE ISOTOPIC EXCHANGE REACTIONS. L. R. Darbee, F. E. Jenkins, and G. M. Harris (Univ. of Buffalo, N. Y.). J. Chem. Phys. 25, 605(1956) Sept.

A mathematical treatment of the kinetics of competitive isotopic exchange reactions such as the exchange of I^{131} with alkyl iodides is offered. (T.R.H.)

6357 A/CONF.15/P/1279
A FEW HETEROGENEOUS ISOTOPIC EXCHANGE REACTIONS. S. Ionescu, I. Negoescu, and I. Gainar (Inst. of Atomic Physics, Bucharest). 17p.

The following partial reactions which are involved in the heterogeneous isotopic exchange may play an important part: diffusion phenomenon in the liquid phase, ion absorption on the crystal surface, surface interchange reaction, diffusion in the solid phase, and dissolution followed by a new crystallization of the precipitate. The contribution of each partial process to the total exchange phenomenon has been determined for the $ZnO-ZnSO_4$ system. The exchange between the Zn^{2+} ions of the insoluble oxide and the Zn^{2+} ions of the $ZnSO_4$ solution was studied at 0, 15, 25, and 35°C by adding Zn^{65} to the solution. (W.D.M.)

7601
ISOTOPIC EXCHANGE REACTIONS OF NEPTUNIUM IONS IN SOLUTION. IV. THE EFFECT OF VARIATION OF DIELECTRIC CONSTANT ON THE RATE OF THE Np(V)-Np(VI) EXCHANGE. Donald Cohen, J. C. Sullivan, E. S. Amis, and J. C. Hindman (Argonne National Laboratory). J. Am. Chem. Soc. 78, 1543-5(1956) April.

The isotopic exchange reaction between Np^{5+} and Np^{6+} has been studied at 0°C, in a medium of aqueous $HClO_4$ containing varying weight percentages of ethylene glycol or sucrose. The data show that the reaction rate for the isotopic exchange is negligibly affected by the variation of the macroscopic dielectric constant in these solvents. This result is discussed in terms of the current theories of the mechanism of electron exchange reactions. (auth)

JETS 2.27

PROCESS FOR SEPARATING GASEOUS OR VAPOROUS SUBSTANCES, MORE ESPECIALLY ISOTOPES. Deutsche Gold-und Siber-Scheideanstalt vorm. Roessler (Germany). British Patent 803,689. Nuclear Eng. 4, 284(1959) June.

Reference is made to B.P. 794,834 which describes a process of separating gaseous or vaporous substances of different molecular weight and/or molecular diameter, in particular isotopes. The separating system consists of a nozzle and an apertured diaphragm which is placed in the path of the jet, formed by the mixture when passing through the nozzle, and dividing the jet into a core stream and a peripheral stream, the heavier and lighter components of the mixture thus being concentrated in the respective component streams. In order to obtain good quality separation, it is important to maintain a specific ratio of the pressure of the gas entering the nozzle to the pressure of the gas leaving the nozzle, this ratio varying from 100 : 1 to 1,000 : 1. In the previously described form of the process, suitably designed pumps were employed for maintaining these pressure ratios with delivery of the streams of vapor or gas.

Where the method is employed in the form of a multi-stage process, a plurality of pumps with high capacities is required making the equipment expensive. In the present patent a revised version of the method is described, eliminating the use of pumps for this purpose. Instead, the transport of the gases and vapors through the separating system is effected by successive vaporization and condensation steps, resulting from periodical addition and withdrawal of heat. The process being carried out in the sub-atmospheric pressure range can also be used for subliming substances, e.g., for the concentration of uranium isotopes from uranium hexafluoride.

PROCESS FOR THE SEPARATION OF GASEOUS OR VAPOROUS SUBSTANCES, MORE ESPECIALLY ISOTOPES. E. W. A. Becker (Germany). British Patent 794,834. Nuclear Eng. 3, 556(1958) Dec.

The mixture to be separated issues from a nozzle-like opening in the form of an expanding jet. The jet is separated by an apertured diaphragm in its path into a peripheral portion and a core portion the latter passing through the aperture. A mixture of 98.5 mol% of hydrogen and 1.5 mol% of deuterium was subjected to the process using a nozzle of 0.47 mm smallest diameter and a conical diaphragm with an opening of 2.2 mm spaced from the nozzle opening 3.1 mm. The pressure was 15 mm Hg ahead of the nozzle. In the chamber around nozzle mouth and diaphragm the pressure was 2×10^{-2} Hg and in the chamber behind the diaphragm 1×10^{-2} Hg. The separation factor A was 1.37−0.02. (Separation factor $A = Nh(1-Nv)/Nv(1-Nh)$ where Nh is the molar fractions of the component with the higher molecular weight behind (h) and in front (v) of the diaphragm in the direction of flow.) (auth)

6511 A/CONF.15/P/1002

SEPARATION OF THE URANIUM ISOTOPES BY THE NOZZLE PROCESS. E. W. Becker, K. Bier, H. Burghoff, O. Hagena, P. Lohse, R. Schütte, P. Turowski, and F. Zigan (Univ. of Marburg, Ger.). 15p.

Preliminary results on the separation of uranium isotopes by the nozzle process, which is based on the pressure diffusion in a free expanding jet stream, are reported. A description is given of the apparatus used, and the optimum operating conditions are determined.

14331

NEW DESIGNS FOR JET EXTRACTION COLUMNS. S. M. Karpacheva, L. P. Khorkhokina, and S. F. Medvedev. Reactor Technol. 1, 60-3(1959) Apr.

Jet and spray columns are discussed and compared with other extraction apparatus. A six-stage jet column is described, and data from experiments with the six-stage column in a solvent extraction set-up are given. Multijet columns with phase inversion are also treated. (T.R.H.)

10987

URANIUM ISOTOPE SEPARATION: A NEW INDUSTRY. G. R. H. Geoghegan. New Scientist 5, 468-72(1959) Feb. 26.

The gaseous diffusion separation process used in the British factory at Capenhurst is described, and consideration is given to the economic aspects of the plant. Information is also included on the basic principles of operation of the electromagnetic, gas-phase centrifuge, and jet processes. (J.H.M.)

11423 IGR-TN/W-1046

United Kingdom Atomic Energy Authority. Industrial Group. Windscale Works, Sellafield, Cumb., England.

THE ESCAPE OF KRYPTON FROM IRRADIATED URANIUM ON HEATING. J. F. Walker. 1959. 16p.

The escape of fission-product krypton from irradiated uranium was studied by heating specimens in vacuo and analyzing the evolved gas by beta counting. Diffusion coefficients were measured over the range 300 to 900°C. The release rates did not follow those predicted by the theory of diffusion. Grain-boundary diffusion is believed to be responsible for this lack of agreement and also for the large variations in release rate between different specimens at the same temperature. Above 900°C, swelling and cracking of the specimens released the gas rapidly; a diffusion process no longer operated. Several experiments were made to find whether the trapping of gas by bubbles reduced the effective diffusion coefficients. However, no reductions in the release rates were found in experiments with specimens known to contain gas bubbles. (auth)

KRYPTON 2.28

9790 AERE-I/R-2693
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE SEPARATION AND PURIFICATION OF KRYPTON-85 AT THE MULTI-CURIE LEVEL. E. J. Wilson and K. J. Taylor. Dec. 1958. 22p. $0.56(BIS).
A description is given of a remote-controlled glass apparatus capable of separating 25 curies of Krypton-85 per working day from dissolver gas containing 10 ppm v/v Krypton-85. (auth)

9229 AERE-C/M-280
Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.
THE ISOTHERM FOR THE ADSORPTION OF KRYPTON ON CHARCOAL. D. F. Sangster. June 1956. 7p.
The isotherms for the adsorption of Kr on charcoal at −40 to 0°C have been calculated from chromatographic data. The isotherm is non-linear above and absorption of about 4 cm^3 NTP (0.2 millimoles) of gas per gm of charcoal. (auth)

THE EXTRACTION, PURIFICATION AND INDUSTRIAL USES OF KRYPTON-85. E. J. Wilson, C. Evans, J. Chadwick, J. Eakins, and K. J. Taylor. Apr. 25, 1955. Decl. Jan. 9, 1957. 18p. (AERE-I/R-1653)
A method of purification, extraction and measurement of Kr^{85} on a curie scale is described. Potential industrial uses of the isotope are also discussed.

LANTHANUM 2.29

A NOTE ON THE SEPARATION OF LANTHANIDES FROM MIXTURES OF THEIR CHLORIDES. J. H. Freeman (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. & Nuclear Chem. 7, 286-7 (1958) Oct.
Since a change in the covalent nature of lanthanides to chlorine bonding should be reflected in the solubilities of the chlorides in organic solvents, experiments were performed which indicate that the solubility differences exist and that it is possible to effect some separation of the lanthanides by fractional crystallization of their anhydrous chlorides from organic solvents. Separations were also effected by utilizing the difference in dehydration time of the lanthanide chlorides. This latter technique is difficult to control and since it cannot readily be adapted to a multistage separation it appears to be of less interest than the fractional crystallization method. (T.B.A.)

10485
SEPARATION OF LANTHANUM FROM THORIUM BY ANION EXCHANGE. Tatsuya Sekine and Nobufusa Saito (Univ. of Tokyo). Nature 181, 1464-5(1958) May 24.
The anion exchange behavior of thorium in sulfuric acid solution and the separation of lanthanum from thorium by anion exchange were investigated. (C.H.)

FISSION PRODUCT RECOIL SEPARATION IN SUSPENSION REACTORS. M. E. A. Hermans and Th.v.d. Plas (R.C.N.-K.E.M.A. Reactor Development Group, Arnhem, the Netherlands). Nuclear Sci. and Eng. 2, 224-6(1957) Apr.
The use of fission product recoil separation in slurry reactors is briefly discussed. The discussion is restricted to a slurry of uranium oxide, in water of pH about 7, as measured at room temperature. The use of active charcoal is suggested for the removal of lanthanides from the slurry system. (B.J.H.)

LANTHANUM 2.29

3791 UCRL-3265
California. Univ., Berkeley. Radiation Lab.
SEPARATION OF THE LANTHANIDES BY ION EXCHANGE WITH ALPHA-HYDROXY ISOBUTYRIC ACID. G. R. Choppin and R. J. Silva. Jan. 20, 1956. 6p. Contract W-7405-eng-48. $1.80(ph OTS); $1.80(mf OTS).

3116 UCRL-3209
California. Univ., Berkeley. Radiation Lab.
ION-EXCHANGE BEHAVIOR OF ACTINIDES AND LANTHANIDES (thesis). Joseph Pleas Surls, Jr. Jan. 1956. 61p. Contract W-7405-eng-48. $10.80(ph OTS); $3.90(mf OTS).

The ion-exchange behavior of tripositive Pu, Am, Cm, Bk, Cf, E, Fm, Ce, Pm, Eu, Gd, Tb, Dy, Ho, Tm, Lu, and Y from Dowex-1 anion-exchange resin with NH_4SCN solutions has been studied. Lanthanides and Y elute sooner than actinides under all conditions studied. Neither actinides nor lanthanides showed a simple elution sequence of the numbers within the series. On elution from Dowex-50 with NH_4SCN the actinides eluted in the usual sequence of decreasing atomic number. The lanthanides studied also exhibited the usual sequence of elution from Dowex-50; however, the actinides eluted sooner than the lanthanides of comparable ionic radius. The absorption of lanth' des, Am, and Cm on Dowex-50 from low ionic strength $HClO_4$ solutions was studied at 25°C. The relative adsorbability decreases from La to Dy, but from Dy to Lu, almost no change in adsorbability occurs. Americium and Cm adsorb with the same strength as lanthanides of comparable crystallographic radius Thermodynamic quantities were evaluated for the adsorption of Pm, Tm, Lu, and Am by studying the variation of adsorbability at 0, 25, and 50°C in weak $HClO_4$. Relative activity coefficients of very dilute $CeCl_3$ in HCl are given for ionic strengths of 0.02 to 0.1. Relative activity coefficients of $M(ClO_4)_3$, where M is a very dilute tripositive actinide or lanthanide ion, $HClO_4$ are given for ionic strengths of 0.03 to 0.73. (auth)

9736 CC-2871
Chicago. Univ. Metallurgical Lab.
THE PRECIPITATION OF LANTHANUM FROM SOLUTION IN THE PRESENCE OF RADIATION. Problem Assignment Number 320 MLC 2001. R. A. Penneman, J. A. Ghormley, S. Gordon, B. Leaf, and A. O. Allen. Apr. 6, 1945. Decl. Feb. 15, 1956. 8p. Contract W-7401-eng-37. $1.80(ph OTS); $1.80(mf OTS).

In order to anticipate radiation–chemical effects in solutions of active La, various solutions and suspensions containing La were irradiated with an electron beam. Separation of La from Ba by the alcoholic HCl method is not rendered less efficient by radiation, although considerable gas evolution occurs. Suspensions of La as hydroxide and as ferrocyanide are not appreciably solubilized by radiation. $La_2(C_2O_4)_3$ is decomposed by radiation, is partially thrown into solution, and finally dissolves completely when all the excess $(C_2O_4)^{2-}$ in the solution has been destroyed. (auth)

MOLYBDENUM 2.30

5822
IMPROVED MOLYBDENUM SEPARATION PROCEDURE. E. M. Scadden (U. S. Naval Radiological Defense Lab., San Francisco). Nucleonics 15, No. 4, 102(1957) Apr.

A modified method is presented for determining Mo activity in fission-product mixtures. (W.L.H.)

11596 ANL-RCV-SL-1094
Argonne National Lab., Lemont, Ill.
SEPARATION OF MOLYBDENUM HEXAFLUORIDE FROM URANIUM HEXAFLUORIDE—SIMPLE DISTILLATION OF URANIUM HEXAFLUORIDE–MOLYBDENUM HEXAFLUORIDE MIXTURES. Interim Report. L. Trevorrow. Aug. 29, 1956. Decl. Mar. 9, 1957. 6p. Contract [W-31-109-eng-38]. $1.80(ph OTS); $1.80(mf OTS).

3792 UCRL-3324
California. Univ., Berkeley. Radiation Lab.
ANION EXCHANGE SEPARATION OF MOLYBDENUM AND TECHNETIUM AND OF TUNGSTEN AND RHENIUM. E. H. Huffman, R. L. Oswalt, and L. A. Williams. Feb. 28, 1956. 12p. Contract W-7405-eng-48. $0.15(OTS).

NEODYMIUM 2.31

6344

RECIPROCAL INFLUENCE OF RARE-EARTH ELEMENTS WHEN EXTRACTED BY TRIBUTYLPHOSPHATE. A. V. Nikolaev and A. A. Sorokina (Inst. of Inorganic Chemistry, Siberian Branch of the Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 129, 341-4(1959) Nov. 11. (In Russian)

The reciprocal influence of rare elements in tributyl phosphate extraction was investigated using neodymium, samarium, and ytterbium in nitric acid media. Direct acidity after introducing rare earth salts was ~12 N. The tabulated results show that instead of salting out, a reverse reaction takes place (the self-salting effect). The self-salting is the result of limited rare earth solubility in the organic phase. With yttrium, the stronger the extraction the earlier the self-salting process appears However, with Nd and Sm the recovery remains constant until the indicator concentration is about 5%. Two series of experiments were undertaken in order to clarify the reciprocal effect. The first series determined the effects of concentrations of cerium earths on the TBP solvent extraction of neodymium, samarium, yttrium, holmium, and ytterbium in nitric acid, with the aqueous to organic ratio 3:1. The composition of the didymium according to spectral lines was 55% Nd, 17% Pr, 3.7% Sm, 7.0% La, 0.72% Eu, 0.7% Gd, < 0.4% Dy, < 0.1% Er, 0.04% Yb, 0.04% Lu, and < 0.1% V. In some cases the didymium concentration of 2 to 5% does not show any effects, and while 20% reduces the extraction of all rare earth elements except ytterbium. The absence of didymium effects on yttrium and its weak effects on Y and Ho suggested that the yttrium earth reciprocal effects would be stronger, especially in cerium earths. Hence, a second series of experiments was made with yttrium concentrates of 2.5% Nd, 0.7% Pr, 2.4% Sm, 4.3% La, < 0.1% Eu, 4.0% Gd, 1.4% Tb, 52% Dy, 4.3% Er, 0.9% Tm, 6.5% Lu, 1.45% V. It was observed that even 2% concentration of the admixture affects the reaction for all rare earths. (R.V.J.)

6414 A/CONF.15/P/2231

VYDELENIE INDIVIDUAL'NYKH REDKOZEMEL'NYKH ELEMENTOV. (Separation of Individual Rare Earth Elements.) D. I. Ryabchikov, M. M. Senyavin, and Yu. S. Sklyarenko (U.S.S.R.). 19p.

After opening up the minerals (by acid, alkali, chlorine, etc., depending on their composition), the sum of RE is divided preliminarily into the cerium and yttrium groups on the basis of the double sulfates or carbonates. Separation of the major part of the cerium prevailing in the cerium group is based on its transformation to the tetravalent state and on the fact that it differs from the trivalent elements with respect to complex formation with oxalate and acetic ions; lower basicity; and extractability of ceri-nitric acid complex by diethyl ether. As the yttrium group is separated mainly by chromotographic procedures, the separation of ballast yttrium (65 to 85% of the group sum) is a very difficult problem. A large proportion can be removed simply and quickly by complex formation with trylon B. As samarium, europium, and ytterbium can be transferred to the bivalent state, they are separated electrolytically on a mercury cathode in the presence of potassium citrate which forms complexes with the RE. Elements of the yttrium group and high-purity compounds of the other RE are produced by ion-exchange chromatography, involving the use of various eluants for certain pre-set experimental parameters (concentration, pH, rate, temperature, etc.). Various analytical procedures were developed and are now in use. X-ray spectral methods are employed for ores and intermediates, spectral and radioactivation-chromatographic methods for checking the purity of the finished products, and a colorimetric method for cerium. Spectral purity was obtained on a semi-commercial scale. (tr-auth)

10466

MODERN METHODS OF SEPARATION OF RARE EARTHS. I. N. Zaozerdkiy and Z. F. Andreyeva. Khim. Nauka i Prom. 1, No. 5, 515-17(1956). (Translated from Referat. Zhur. Khim. No. 9, 1957, Abstract No. 30266.)

NIOBIUM 2.32

See also, this section,

ZIRCONIUM (2.53).

1789

A STUDY OF THE IODIDE NIOBIUM PROCESS. Robert F. Rolsten (E. I. du Pont de Nemours & Co., Gibbstown, N. J.). J. Electrochem. Soc. 106, 975-80(1959) Nov.

It was established that the rate of deposition of niobium by the thermal decomposition of niobium iodides can be expressed in units of moles of niobium deposited per unit length of a deposition element per unit of time. The rate of deposition of niobium was studied (a) with deposition temperatures from 750 to 1100°C, (b) with feed material temperatures from 240 to 470°C, and (c) with crude niobium with different surface areas. (auth)

THE PREPARATION OF SOLUTIONS OF RADIOCHEMICALLY PURE NIOBIUM (^{95}Nb) AND ZIRCONIUM (^{95}Zr). C. J. Hardy and D. Scargill (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. & Nuclear Chem. 9, 322-4(1959) Mar.

Two extraction methods are described for the preparation of Nb^{95} and Zr^{95}. These methods are solvent extraction with thenoyltrifluoroacetone and a paper chromatographic-solvent extraction method. (J.H.M.)

13318

NIOBIUM-TANTALUM SEPARATION. H. A. Wilhelm and R. A. Foos (to U. S. Atomic Energy Commission). U. S. Patent 2,871,092. Jan. 27, 1959.

The usual method for the separation of tantalum and niobium consists of a selective solvent extraction from an aqueous hydrofluoric acid solution of the metals. A difficulty encountered in this process is the fact that the corrosion problems associated with hydrofluoric acid are serious. It has been found that the corrosion caused by the hydrofluoric acid may be substantially reduced by adding to the acidic solution an amine, such as phenyl diethanolamine or aniline, and adjusting pH value to between 4 and 6.

6354

PROCESS FOR EXTRACTING AND SEPARATING NIOBIUM AND TANTALUM. (to CIBA, Ltd.). British Patent 825,604. Dec. 16, 1959.

A process is described for separating Ta and Nb in ores, oxide mixtures, slags, or concentrates. The oxides are chlorinated to produce Nb oxychloride and $TaCl_5$. The $TaCl_5$ can then be extracted with liquid SO_2. (T.R.H.)

5284

CYCLOHEXANONE EXTRACTION OF TANTALUM AND NIOBIUM FROM SULFURIC ACID SOLUTIONS. Ya. G. Goroshchenko, M. I. Andreeva, and A. G. Babkin. Zhur. Priklad. Khim. 32, 1904-13(1959) Sept. (In Russian)

Experiments confirmed the preferential extraction of Ta from mixtures with Nb in sulfuric acid and ammonium nitrate. Ta concentration in the aqueous phase was reduced to 0.03 to 0.04% of the initial value while Nb extraction did not exceed 70%. Extracted Ta is complexed as a fluosulfate which remains stable in sulfuric acid and ammonium sulfate washings while complexed Nb is worked out. (R.V.J.)

5285

EXTRACTION AND SEPARATION OF NIOBIUM AND TITANIUM BY OXALIC ACID AND ION EXCHANGE METHODS. I. D. Fridman and I. N. Yudina (Central Scientific Research Inst. of Geology and Exploration). Zhur. Priklad. Khim. 32, 1914-19(1959) Sept. (In Russian)

The extraction separation of niobium and titanium from oxalic acid solutions by anion resin EDE10P is achieved by selectively eluting niobium with 2M(10%) sodium chloride and titanium with 1M hydrochloric acid. The exchange volume of the resin for niobium is 5.5% of the dry-resin weight. A complete regeneration of the resin takes place during niobium and titanium extraction. The ion exchange method produces niobium pentoxide containing 98.0% Nb_2O_5 and 1.8 to 2% TiO_2. (R.V.J.)

NIOBIUM 2.32

10930

NIOBIUM AND ZIRCONIUM SEPARATION BY SELENIOUS ACID. I. P. Alimarin and E. I. Stepanyuk (Lomonosov Inst. of Fine Chemical Tech.). Zavodskaya Lab. 24, 1065-6(1958). (In Russian)

Separation of niobium from zirconium by selenious acid precipitation showed satisfactory results. However, a certain loss of niobium was observed with large zirconium contents. A spectral analysis of the niobium pentoxide precipitations showed the presence of less than 0.05% zirconium. (R.V.J.)

THE SEPARATION AND DETERMINATION OF NIOBIUM AND TANTALUM BY PARTITION CHROMATOGRAPHY. Ian A. P. Scott and Robert J. Magee (Queen's Univ., Belfast). Talanta 1, 329-33(1958) Nov.

A procedure is outlined for the separation and determination of niobium and tantalum by paper chromatography. A mixture of methyl isobutyl ketone and hydrofluoric acid was used as solvent and the metals were detected by means of 8-hydroxyquinoline. The minimum amount of each element detectable is 20 μg. The procedure was applied successfully to the quantitative determination of small amounts of niobium and tantalum in a steel. (auth)

16302

SEPARATION OF NIOBIUM AND TANTALUM WITH CUPFERRON. A. K. Majumdar and J. B. Ray Chowdhury (Jadavpur Univ., Calcutta). Anal. Chim. Acta 19, 18-22 (1958) July.

An attempt to separate niobium and tantalum by cupferron was only moderately successful at pH 4.5 to 5.5 in the presence of a magnesia mixture as a coagulating agent. A more satisfactory separation of niobium and tantalum from each other, tried out up to ratios of 30 : 1 and 1 : 30, is effected with Sn^{2+} or Sn^{4+} as a co-precipitating agent. Under the conditions described niobium can be separated, in the presence of complexone III, from almost all the ions except U, Be, Ti and PO_4^{-3}. Iron and other tervalent elements, when present in 100 fold excess with respect to niobium, require double precipitation. The method gives highly satisfactory results when applied to the analysis of niobium in niobium–molybdenum stainless steel. The use of tita-

16303

SEPARATION OF NIOBIUM AND TANTALUM WITH N-BENZOYL-N-PHENYLHYDROXYLAMINE. A. K. Majumdar and A. K. Mukherjee (Jadavpur Univ., Calcutta). Anal. Chim. Acta 19, 23-6(1958) July.

The use of N-benzoyl-N-phenylhydroxylamine for the separation of niobium and tantalum, allows a satisfactory estimation of niobium from a tartrate solution at an acidity of 2.0N. The pH range for complete precipitation can be extended to 6.5. For tantalum precipitation, the pH of the solution should be below 1.5 and the acidity may even be above 2.0N. At pH 3.5 to 6.5, niobium is completely precipitated and tantalum remains in solution; the latter is precipitated by lowering the pH. Niobium and tantalum in ratios of 1 : 16 to 100 : 1 can be separated by a single precipitation, in the case of a ratio of 1 : 100 precipitation must be carried out twice. Titanium, zirconium, vanadate and molybdate interfere with the determination of niobium though other ions have no effect in the presence of complexone III and tartaric acid. The precipitates are granular and easy to filter and wash. The time taken for a complete analysis is much less than that of other methods. (auth)

SEPARATION OF NIOBIUM AND TANTALUM WITH ORGANIC HYDROXAMIC ACIDS AND PHENYLARSONIC ACID. Anil Kumar Majumdar and Asit Kumar Mukherjee (Jadavpur Univ., Calcutta). Naturwissenschaften 45, 239-40(1958).

An investigation of the separation of niobium and tantalum with organic hydroxamic acids reveals that salicylhydroxamic acid precipitates both elements in the presence of a tartrate from highly acid solutions to solutions with a maximum pH of 6.4. With citrate the pH of the solution can be extended only to 3.0. With oxalate tantalum precipitates under the same pH conditions as with tartrate, but niobium begins to precipitate at pH 4.9. Cinnamyl hydroxamic acid behaves in the same way as the salicyl derivative with the pH of precipitation extended to 6.5 in oxalate solution, 8.5 in tartrate solution, and 2.0 for tantalum and 2.8 for niobium in citrate solution. With phenylarsonic acid tantalum can be precipitated from an ammonium oxalate–sulfuric acid solution, but the complete precipitation of niobium occurs only when the pH is over 4.8. (J.S.R.)

NIOBIUM 2.32

16307

THE DECOMPOSITION POTENTIALS OF SOME NIOBIUM COMPOUNDS AND THE SEPARATION OF NIOBIUM BY THE ELECTROLYSIS OF MELTS. Ye. I. Gurovich. Zhur. Neorg. Khim. 3, 450-5(1958). (In Russian)

The decomposition potentials of K_2NbF_7 and Nb_2O_5 were determined in molten mixtures of KF and KCl. The melt was maintained at a temperature of 850 ± 20°C. The decomposition potential for K_2NbF_7 is 1.65 v; the addition of Nb_2O_5 raised the potential to 2.56 v. A method for the production of metallic, powdery niobium by the electrolysis of molten salts is described. The melt consists of KF, KCl, K_2NbF_7, and freshly precipitated Nb_2O_5. The Nb produced has high purity with only 0.01% Nb_2O_5 at most. (J.S.R.)

1316

STUDY OF NIOBIUM AND TANTALUM COMPLEXES FOR SOLVENT-EXTRACTION SEPARATIONS. Presented at the International Conference on Radioisotopes in Scientific Research, Sept. 9-20, 1957 at Paris. No. UNESCO/NS/RIC/50. E. Bruninx and J. W. Irvine, Jr. London, Pergamon Press, Ltd., 1957. 8p.

Carrier-free 10.1-day Nb^{92} and 112-day Ta^{182} of high specific activity were used to explore various possibilities for the extraction of Nb or Ta from aqueous solutions containing complexing agents into various organic solvents, and to determine conditions for good separation of Nb from Ta. Good extraction of Nb was obtained at pH 10 into nitrobenzene, amyl acetate, and bis(2-chloroethyl) ether with 5,7-dichloro-8-quinolinol dissolved in the organic solvent, the distribution ratio (organic/aqueous) being about 4. Ta did not extract. Studies were made on the extraction of Nb and Ta as chlorides from HCl solutions of various concentrations, using numerous solvents. In every case the extractability of Nb is much higher than Ta, in several cases by more than the factor 10^3. In all systems, the extractabilities rise rapidly with increasing HCl until miscibility is approached, giving for example values up to 53 for methylisobutyl ketone with 6.5 M HCl, and 6 for bis(2-chloroethyl) ether with 8.3 M HCl. The addition of 0.05 M $H_2C_2O_4$ improved the reproducibility without lowering greatly the distribution ratios for Nb. The distribution data give some information on the nature of the complexes and provide the basis for practical separation of these elements from others and one another. (auth)

11498

SOLVENT EXTRACTION PROCESS FOR THE SEPARATION OF TANTALUM AND NIOBIUM VALUES. H. G. Hicks et al. (to U. S. Atomic Energy Commission). U. S. Patent 2,795,481. June 11, 1957.

A process of separation of Ta from Nb is given. The process consists in extracting, with diisopropyl ketone, an aqueous hydrofluoric acid-mineral acid solution of a mixture of Nb and Ta. Tantalum extracts into the ketone; the Nb remains in the water. Tantalum may be recovered by adding H_3BO_3 to the combined washings from the extraction to complex the fluorides, and precipitating the metal as the hydrated oxide by adding NH_4OH. (auth)

EXTRACTION OF NIOBIUM RHODANIDE COMPLEXES WITH ORGANIC SOLVENTS USING RADIOACTIVE ISOTOPES Nb^{95}. K. V. Troitskiĭ (Vernadskiĭ Moscow Inst. of Geochemistry and Analyt. Chemistry). Zhur. Analit. Khim. 12, 349-54(1957) May-June. (In Russian)

Optimum conditions have been found for the extractive separation of Nb, and the best solvents are suggested.

7386

SEPARATION OF NIOBIUM FROM TANTALUM. P. G. England and I. S. Broadley (to U. K. Atomic Energy Authority). British Patent 767,135. Nuclear Eng. 2, 224 (1957) May.

Niobium and tantalum occur together in nature and have similar chemical properties. This renders separation difficult. It has now been observed that niobium pentachloride is more readily reduced to the trichloride than tantalum pentachloride. The pentachlorides of niobium and tantalum are formed by chlorination, the mixed pentachlorides treated with a reducing agent, then the tantalum pentachloride is removed by volatilization. (auth)

6409

PURIFICATION OF NIOBIUM BY SINTERING. I. LABOTORY INVESTIGATION OF PURIFICATION BY SINTERING. II. DEVELOPMENT OF A COMMERCIAL SINTERING PROCESS. W. G. O'Driscoll and G. L. Miller (U. K. Atomic Energy Authority, Industrial Group, Culcheth). J. Inst. Metals 85, 379-84(1957) Apr.

The purification of Nb by sintering in vacuo has been studied on both a laboratory and a commercial scale. Gaseous impurities were eliminated by vacuum treatment at temperatures up to 2300° C. When both elements were present, simultaneous removal of O_2 and C as CO was achieved. In the presence of O, Si was also eliminated as SiO. Ductile massive Nb, containing O_2 0.05, N_2 0.01, and C and Si <0.01 wt.-%, has been prepared on a commercial scale. (auth)

NIOBIUM 2.32

SEPARATING NIOBIUM AND TITANIUM IN THE FORM OF COMPLEX CHLORIDES. B. Ya. Tratsevitskaya, V. G. Trusova, D. M. Chizhikov, and V. N. Korsunskaya. Trudy Inst. Met. Akad. Nauk No. 2, 87-91(1957). (Translated from Referat. Zhur. Met. No. 2, 1958, p. 63)

A study was made of the behavior of complex chlorides of Nb and Ti with K and NH_4 in HCl solutions saturated with gaseous HCl at temperatures from 0 to −10°C. The Ti concentration varied from 0.3 to 15 g/l and the Nb concentration from 5 to 15 g/l. The Ti:Nb ratio varied from 1:1 to 1:150. The potassium or ammonium compounds were added in excess amounts. At low concentrations of Ti, it was possible to precipitate 96%, but the precipitation effectiveness decreased as the Ti concentration increased. ~~The percentage~~ precipitated increased when the temperature was lowered to −10°C.

5259 ISC-802

Ames Lab., Ames, Iowa.

SEPARATION OF NIOBIUM AND TANTALUM BY LIQUID EXTRACTION. Ernest L. Koerner, Jr., Morton Smutz, and H. A. Wilhelm. Dec. 1956. 68p. Contract W-7405-eng-82. $0.40(OTS).

A lab scale process was devised which produced several pounds of niobium oxide containing less than 700 ppm tantalum oxides and several pounds of tantalum oxide containing less than 100 ppm niobium oxides. The steps in the process are: digestion of ore or concentrate with HF, solvent extraction of Nb and Ta into methyl isobutyl ketone, solvent extraction separation of Nb and Ta, solvent extraction purification of Nb, and stripping and solvent regeneration. (T.R.H.)

3229

PROCESS OF SEPARATING TANTALUM AND NIOBIUM VALUES FROM EACH OTHER. H. A. Wilhelm (to U. S. Atomic Energy Commission). U. S. Patent 2,767,047. Oct. 16, 1956.

A solvent extraction process for separating Ta and Nb values from a mixture of the two as fluorides in an aqueous mineral acid solution is described. The aqueous solution, which is preferably about 6.5 M in acid, comprised of Hf about 0.4 M and the balance HCl, is treated with an oxygenated immiscible organic liquid such as TBP, mesityl oxide and the like. The Ta values are preferentially transferred to the organic phase leaving the Nb values in the aqueous phase. (auth)

1830

EXTRACTION OF CUPFERRONATES OF NIOBIUM, TANTALUM, AND TITANIUM. I. P. Alimarin and I. M. Gibalo (Lomonosov Moscow State Univ.). Doklady Akad. Nauk. S.S.S.R. 109, 1137-9(1956) Aug. 21. (In Russian)

A method is offered for segregation of Ti from materials containing Nb, Ta, and Ti. A satisfactory result was obtained of Ti segregation from the solution of Nb_2O_5 + Ta_2O_5, with various ratios of Ti, by extraction of cupferronates with the isoamyl alcohol pH5. The segregation was checked by H_2O_2 and by radioactive isotopes Nb^{95} and Ta^{182} with activity of 2000 to 3000 imp/min per 1 ml. (R.V.J.)

CONCERNING ELECTROLYTIC REDUCTION OF NIOBIUM IN SOLUTIONS OF ITS SULFATE. Ye. I. Krylov and V. S. Kolevatova. Zhur. Priklad. Khim. 29, No. 8, 1292-5(1956). (Translated from Referat Zhur. Khim. No. 4, 1957, abstract No. 11362)

Study is made of the influence of current density i, temperature, and composition of electrolyte on yield, on basis of current consumption (YC), in the electrolysis of solutions of Nb^{5+}. YC is considerably higher with Pb than with Hg. On increase of i, on lowering of temperature and of Nb^{5+} concentration, YC drops. On increase of H_2SO_4 content YC increases only slightly. The results obtained are attributed to the influence of the factors under study on the diffusion rate of Nb^{5+} to the cathode.

6351

SEPARATION OF NIOBIUM AND TANTALUM BY THE LIQUID EXTRACTION METHOD. D. I. Ryabchikov and M. P. Volynets (Vernadskiĭ Inst. of Geochemistry and Analytical Chemistry, Moscow). Zhur. Anal. Khim. 14, 700-4 (1959) Nov.-Dec. (In Russian)

With the use of radioactive indicators, the influence of hydrofluoric acid and tributyl phosphate concentrations, temperature, and hydrochloric and sulfuric acids on the distribution of niobium and tantalum fluoride complexes between water phase and tributyl phosphate, when the extraction is carried out in static conditions, was studied. The method developed for the separation of niobium and tantalum can be used for the analysis of binary tantalum–niobium alloys. An extraction packing continuous column was used for separating mixtures of tantalum and niobium. It was shown that in the conditions adopted (h_e of packing is 144 mm) it is possible to obtain niobium of 99.7 to 100% purity. (auth)

NUCLEAR RECOIL 2.33

12531

THE SZILLARD CHALMERS EFFECT IN THE γ-QUANTUM IRRADIATION OF CHROMATES AND BICHROMATES. D. K. Popov (Zhdanov Leningrad State Univ.). Zhur. Fiz. Khim. 33, 405-10(1959) Feb. (In Russian)

The possibility of concentrating Cr^{49} formed from the alkaline metal and ammonium chromates and bichromates in line with the reaction $Cr^{50}(\gamma,n)Cr^{49}$ has been demonstrated. The enrichment factor is $> 10^4$. The retention factor in the irradiated solid preparations depends upon the time passing from the dissolution of the salt and the isolation of the Cr^{49} on iron hydroxide, whereas on irradiating aqueous solutions the retention is always of zero value. On dissolution of the irradiated crystals the unstable valence forms of chromium are distributed between Cr^{3+} and Cr^{6+}. (auth)

SOME NEW ASPECTS OF THE PRODUCTION OF RADIOISOTOPES POSSESSING HIGH SPECIFIC ACTIVITY WITH THE AID OF HOT ATOM CHEMICAL PROCESSES ACCOMPANYING THE NUCLEAR REACTION (n,γ). Kristian Svoboda (Biofysikální ústav ČSAV, Brno). Jaderná energie 5, 157-60(1959). (In Czech.)

The production of radioisotopes by the (n,γ) reaction is very cheap and often used. The problem of separating the activated radioisotopes from the great bulk of the inactive mother element has been solved by the method of Szilard and Chalmers. The application of this method, however, is in many cases impossible because of the unfavorable value of the exchange velocities of radioisotope and mother element compounds. The task was to examine the quantitative influence of exchange reactions on the yields of the Szilard-Chalmers method. If the product of the mother element concentration and of the exchange constant is greater than 10^2 λ, it is impossible to get a reasonable yield when using the hitherto static method of the Szilard-Chalmers process. With recourse to the results of mathematical analysis it was possible to work out a new dynamic method. Its principle consists of the simultaneous activation and extraction of the mother compound. In this way it is possible to overcome the unfavorable influence of the exchange reactions on the Szilard-Chalmers process. (auth)

1249

CHEMICAL FATE OF RECOILING FISSION FRAGMENTS. D. Hall (Univ. of Auckland, N. Z.). p.580-2 of "Australian Atomic Energy Symposium, 1958."

A study was made of the association of iodine fission fragments with the elementary iodine formed by uranyl iodate decomposition on irradiation. The proportion thus associated is independent of neutron dose, and is as follows: Iodine 131, 14%, iodine 132, ~35%, iodine 133, 18%, iodine 135, ~60%. The results indicate that the chemical fate of the recoil atom is determined in a reaction involving the primary fragment and its environment. (auth)

GA-617

General Atomic Div., General Dynamics Corp., San Diego, Calif.

SZILARD-CHALMERS PROCESSES. Quarterly Status Report [for] September 15–December 14, 1958. Rodman A. Sharp. Dec. 16, 1958. 14p. Project No. 49. Contract AT(04-3)-167, Project Agreement No. 3. $3.30(ph), $2.40(mf) OTS.

Further experiments were performed on Szilard-Chalmers systems measuring yields and enrichments. Work was done on 15-hr Na^{24}, 38-min Cl^{38}, 12-sec F^{20}, 2.6-hr Mn^{56}, 12-hr Cu^{64}, 14-hr Zn^{69}, and 27-hr Sn^{121}. The irradiations were accomplished in the rotary specimen rack of General Atomic's TRIGA Reactor. The thermal neutron flux at this position was 2×10^{13} nvt/kw-hr. (W.D.M.)

THE SZILARD-CHALMERS REACTION IN SOLIDS. PART I. CHEMICAL EFFECTS OF NUCLEAR RECOIL. Garman Harbottle and Norman Sutin (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem. 62, 1344-51(1958) Nov.

A model is proposed to explain the chemical effects of nuclear recoil in solids. It is based upon the Seitz and Koehler treatment of the slowing-down of energetic atoms and makes use of the concept of the displacement spike. Although the model starts from physical considerations, it postulates specific chemical reactions during the lifetime of the displacement spike. The approach is compared with that of other workers and important differences are shown. (auth)

NUCLEAR RECOIL 2.33

THE SZILARD-CHALMERS EFFECT IN SOLID ETHYL BROMIDE. Miriam Milman (Nuclear Physics Group of the Ecole Normale Supérieure, Paris). J. Am. Chem. Soc. 80, 5592-5(1958) Nov.

The contribution of diffusion dependent reactions following radiative neutron capture by the bromine atom in solid ethyl bromide, has been investigated. The scavenger effect of elementary bromine and 1,2-dibromoethylene, as well as the influence of irradiation temperature and crystalline structure were examined. It was found that the high yield of radioactive organic species is due to a great enhancement of hot processes, the diffusion controlled reactions having a smaller relative importance than in the case of the neutron irradiation of liquid ethyl bromide. (auth)

REACTIONS OF RECOIL BROMINE ATOMS IN ALKALI BROMATES. Joseph Jach and Garman Harbottle (Brookhaven National Lab., Upton, N. Y.). Trans. Faraday Soc. 54, 520-5(1958) Apr.

An investigation has been made of the recoil and post-irradiation annealing reactions of Br^{80m}(4.6 h) and Br^{82}(35.8 h) in the crystalline alkali bromates. The retentions of both isotopes in sodium, potassium, rubidium, and cesium bromates are initially nearly the same but increase at different rates on annealing, the Br^{82} in each case increasing the more rapidly. Lithium bromate shows different behavior: the increase in retention on annealing is nearly the same for both isotopes. In addition, the radioactive recoil bromine in lithium bromate is found in the form of hypobromite ion as well as bromate and bromide. (auth)

8305

NUCLEAR RECOIL AS MEANS OF FISSION PRODUCT SEPARATION. Richard Wolfgang (Brookhaven National Lab., Upton, N. Y.). J. Inorg. and Nuclear Chem. 2, 180-3 (1956) Mar.

It has been demonstrated that, by use of a suitable heterogeneous system, the nuclear recoil of fission products can be used to effect their complete separation from the parent fissile material. The potentialities of this simple technique are briefly discussed. (auth)

APPLICATION OF NUCLEAR RECOIL TO THE PREPARATION OF RADIOACTIVE ISOTOPES WITHOUT A DRIVING DEVICE. J. Pauly and P. Sue. J. phys. radium 18, 22-6 (1957) Jan. (In French)

19998 CEA-tr-X-145

SEPARATION PAR RECUL DES ÉLÉMENTS LOURDS TELS QUE L'URANIUM ET LE NEPTUNIUM D'AVEC LEURS PRODUITS DE FISSION. (Recoil Separation of Heavy Elements Such as Uranium and Neptunium from their Fission Products.) T. Nakai and S. Yajima. Translated into French by S. S. Minn from Nippon Kagaku Zasshi 79, 1267-8(1958). 8p.

A study was made of the efficiency of the recoil method for the separation of uranium from its fission products. In the first test powdered uranium oxide, U_3O_8, was mixed with powdered oxalic acid and irradiated. The sample was dissolved in ammonia and filtered. The uranium fission products were carried with the oxalic acid and separated from the undissolved uranium oxide. In a similar test the uranium oxide was mixed with graphite. After irradiation a zinc bromide solution was added to the sample and the mixture centrifuged. The graphite contained most of the activity. In a third investigation the uranium oxide–graphite mixture was boiled in nitric acid and the undissolved graphite removed by filtration. The results showed that the fission products were captured by the graphite. (J.S.R.)

SZILARD-CHALMERS REACTION IN SOME RHENIUM COMPOUNDS. George K. Schweitzer and Dale L. Wilhelm (Univ. of Tennessee, Knoxville). J. Inorg. and Nuclear Chem. 3, 1-8(1956) Aug.

This work was initiated in an attempt to contribute information on the behaviour of Re compounds when undergoing the Szilard-Chalmers reaction. Several compounds of Re were prepared, and from these experiments some preparations have been more carefully elaborated than had previously been done. An interpretation of perrhenate irradiations was made on the basis of a theory of rapid recombination of recoil fragments within a solvent molecule "cage." While an indication of dependence of retention upon degree of covalency of the ligand bonds in Re complex compounds was found, the dependence was not conclusively attributed to this property alone. The best method of producing high-specific-activity radioactive perrhenate solutions found in this work was by irradiation of an aqueous solution of K_2ReCl_6. (auth)

NUCLEAR RECOIL 2.33

19951 CEA-tr-R-655
ENRICHISSEMENT EN RADIO-ISOTOPES D'ANTIMOINE À L'AIDE DU TRIPHENYLDIFLUORANTIMOINE PAR LA MÉTHODE DES ATOMES DE RECUL. (Enrichment in the Radioisotopes of Antimony with the Aid of Diphenylstibine Difluoride by the Method of Recoil Atoms.) V. D. Nefedov and L. N. Evtikheev. Translated into French by B. Vinogradoff from Zhur. Fiz. Khim. 30, 2090-2(1956). 9p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 11, as abstract No. 1975.

6444 A/CONF.15/P/1094
THE CHEMICAL FATE OF A RADIOACTIVE ATOM. D. L. Baulch and J. F. Duncan (Univ. of Melbourne). 22p.

The chemical reactions which an atom may undergo after decay are determined by the degree of atomic and molecular excitation caused by the decay, the recoil energy of the atom, and the kinetic and thermodynamic properties of the resulting ion or free radical. The role of excitation phenomena and the conditions under which its effects might be minimized are considered in detail. From this, the best conditions for using the recoil process for various purposes are evaluated. Evidence from ionization by gamma radiation, charge production in radioactive decay, internal conversion radiative neutron capture, and decay is considered to determine when conditions can be controlled so that electronic excitation is lost before the bond between the radioactive atom and its parent molecule is affected. The results of this study are applied to the production of high specific activity sources by nuclear reactions and to measurements of chemical binding energies. (J.S.R.)

6890 A/CONF.15/P/2097
SOME NEW ASPECTS OF PRODUCING HIGH SPECIFIC ACTIVITIES OF RADIOISOTOPES WITH THE AID OF HOT ATOM CHEMISTRY PROCESSES ACCOMPANYING THE NUCLEAR (n,γ) REACTION. Kristian Svoboda (Czechoslovakia). 20p.

Experiments were carried out in an effort to increase the specific activity of radioisotopes produced by the (n,γ) reaction. Quantitative studies were made on the effect of exchange reactions on the yield of the products resulting from the Szilard-Chalmers reaction, and a formula was derived for characterizing the results of the reaction. Expressions are incorporated into the equation which characterize the influence of exchange reactions and allow comparison of results obtained with neutron sources having various intensities of accompanying gamma radiation. (C.H.)

6475 A/CONF.15/P/1650
STUDY OF THE POSSIBILITY OF PREPARATION OF HIGH SPECIFIC ACTIVITY Co-60 THROUGH SZILARD-CHALMER'S REACTION. Amar Nath, Jagdish Shankar, and S. B. Srivastava (Atomic Energy Establishment, Trombay, India). 10p.

Several chelates of Cobalt (III) were studied. It was found that great care is necessary in the preparation and purification of the complexes so as to eliminate all traces of cobaltous impurities. The choice of the methods used for the separation of Co^{60}, along with Co(II) was guided by the ease of manipulation and the necessity to avoid decomposition of the irradiated complex during the process. The enrichment factor is profoundly influenced by the conditions of neutron irradiation, such as γ flux and temperature. It also depends on the time which elapses between irradiation and the chemical separation and the temperature at which the sample is stored. (auth)

1544
RECOIL TRITIUM REACTIONS AT AN ASYMMETRIC CARBON: L(+)-ALANINE. Jack G. Kay, R. P. Malsan, and F. S. Rowland (Univ. of Kansas, Lawrence and Princeton Univ., N. J.). J. Am. Chem. Soc. 81, 5050-3(1959) Oct. 5.

Recoil tritium reactions with L(+)-alanine were investigated in both crystalline form and in aqueous solution. The T for H substitution at the asymmetric carbon atom occurs with complete retention of configuration in the crystal and occurs for 0.01 % of the total tritium in the liquid solution. More than 85% of the T for H substitutions in the methyl group in both cases proceed with retention of optical configuration. (auth)

OXIDATION 2.34

See also, under PROCESS CHEMISTRY AND ENGINEERING,

SPECIAL PROCESSES--Fluorox (6.17.09),

Chemical Processing with Nuclear Power Industry
II. High Temperature Process
F. S. Martin and G. L. Miles
Atomic Eng. Technical 7, SS-8 (1956)

Oxidation Methods for Fission Products are discussed.

ACID-BASE REACTIONS IN OXIDATION MECHANISMS. Frederick R. Duke (Iowa State Coll., Ames). Anal. Chem. 31, 527-9(1959) Apr.

The hypothesis is advanced that in general, oxidation-reduction reactions are preceded by, or are simultaneous with, an acid-base step. Application of the hypothesis allows the research analytical chemist to decide such things as when a reaction might be slow and what catalyst might be effective for a given reaction. (auth)

6369

IMPROVEMENTS IN OR RELATING TO PRODUCTION OF RADIOISOTOPES. J. C. Charlton and C. C. Evans (to United Kingdom Atomic Energy Authority). British Patent 784,125. Sept. 28, 1955. Nuclear Power 3, 44(1958) Jan.

Carbon 14 is prepared by neutron irradiation of nitrogen compounds—calcium, ammonium, and potassium nitrates have been used. Previous method of recovery was by bringing the nitrate into aqueous solution and acidifying it to release carbon dioxide and monoxide, which were then absorbed in caustic alkali. In the method described in this paptent, an irradiated nitride—preferably finely divided aluminum nitride—is slowly oxidized at 900°C by a stream of oxygen, and the resultant gases passed through a train of bubblers containing aqueous alkali metal hydroxide solution to absorb the radioactive carbon dioxide formed.

10845 CF-58-6-119
Oak Ridge National Lab., Tenn.
ON THE KINETICS OF OXIDATION BY NITRIC ACID. J. E. Savolainen. June 26, 1958. 8p. Contract [W-7405-eng-26]. $1.80(ph), $1.80(mf) OTS.

A method of predicting the oxidation rates by HNO_3 in aqueous solutions is indicated by the results of experiments on the ferrous nitroso clock reaction. (auth)

8729

THE REMOVAL OF RADIOACTIVE ZIRCONIUM AND RUTHENIUM FROM PROCESS SOLUTIONS: PERMANGANATE PRE-TREATMENT. Roy C. Feber (Knolls Atomic Power Lab., Schenectady, N. Y.). pp. 247-56 in "Progress in Nuclear Energy. Series III. Process Chemistry. Volume 2."

A survey is made of methods of decontamination of process feeds from fission products. Procedures with permanganate for the removal of at least 90 to 95% of fission product zirconium, niobium, ruthenium, and iodine from process feeds are discussed. (auth)

6371

SEPARATION OF RUTHENIUM FROM AQUEOUS SOLUTIONS. C. F. Callis and R. L. Moore (to U. S. Atomic Energy Commission). U. S. Patent 2,903,332. Sept. 8, 1959.

The separation of ruthenium from aqueous solutions containing uranium, plutonium, ruthenium, and fission products is described. The separation is accomplished by providing a nitric acid solution of plutonium, uranium, ruthenium, and fission products, oxidizing plutonium to the hexavalent state with sodium dichromate, contacting the solution with a water-immiscible organic solvent, such as hexone, to extract plutonyl, uranyl, ruthenium, and fission products, reducing with sodium ferrite the plutonyl in the solvent phase to trivalent plutonium, re-extracting from the solvent phase the trivalent plutonium, ruthenium, and some fission products with an aqueous solution containing a salting out agent, introducing ozone into the aqueous acid solution to oxidize plutonium to the hexavalent state and ruthenium to ruthenium tetraoxide, and volatizing off the ruthenium tetraoxide.

POLONIUM 2.35

7093
POLONIUM. THE NEGLECTED ELEMENT. Atomics 8, 173-4(1957) May.
Methods of separation, properties, and compounds of polonium are summarized. (M.H.R.)

NEW METHODS OF PREPARING POLONIUM METAL. K. W. Bagnall, P. S. Robinson, and M. A. A. Stewart (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Soc. 3426-8(1958) Oct.
Polonium metal has been prepared by the action of aqueous ammonia on polonium hydroxide and of anhydrous liquid ammonia on the hydroxide and some other polonium compounds. It can also be prepared by reducing polonium hydroxide with hydrazine, hydroxylamine, or sodium dithionite in alkaline solution and polonium tetrachloride with stannous chloride, titanous chloride, or sodium dithionite in hydrochloric acid. (auth)

16922 AERE-C/R-2566
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE POLONIUM CHEMISTRY PROJECT (AUGUST 1953–APRIL 1958). K. W. Bagnall, J. H. Freeman, D. S. Robertson, P. S. Robinson, and M. A. A. Stewart. July 1958. 19p. $0.54(BIS).
The chemistry of polonium, except for its separation from lead and its handling, is discussed. The preparation of the pure metal by sublimation on Ag foil is described. Data on 40 compounds are given. (T.R.H.)

6403
POLONIUM MONOSULPHIDE. K. W. Bagnall and D. S. Robertson (Atomic Energy Research Establishment, Harwell, Berks). J. Chem. Soc. 1044-6(1957) Mar.
Polonium monosulfide was prepared on the milligram scale; its decomposition under vacuum has been used as the basis of a new method for the preparation of pure Po. (auth)

THE POLONIUM NITRATES. K. W. Bagnall, D. S. Robertson, and M. A. A. Stewart (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Soc. 3633-6(1958) Oct.
Polonium tetranitrate and two basic nitrates have been prepared, and evidence for the existence of a nitrite has been obtained. The cation-exchange behavior of polonium in nitric acid solution has been investigated. (auth)

2494
POLONIUM SEPARATION PROCESS. D. G. Karraker (to U. S. Atomic Energy Commission). U. S. Patent 2,894,817. July 14, 1959.
A liquid-liquid extraction process is presented for the recovery of polonium from lead and bismuth. According to the invention an acidic aqueous chloride phase containing the polonium, lead, and bismuth values is contacted with a tributyl phosphate ether phase. The polonium preferentially enters the organic phase which is then separated and washed with an aqueous hydrochloric solution to remove any lead or bismuth which may also have been extracted. The now highly purified polonium in the organic phase may be transferred to an aqueous solution by extraction with aqueous nitric acid.

5274
SOLVENT EXTRACTION STUDIES WITH POLONIUM. K. W. Bagnall and D. S. Robertson (U. K. Atomic Energy Authority, Harwell, Didcot, Berks.). J. Chem. Soc. 509-12 (1957) Feb.
The extraction of Po from HCl solution by dithizone may involve the complex $PoODz_2$, and the complex $PoCl_4 \cdot 2TBP$ may be formed in the extraction with TBP. The dependence of the partition coefficient on the acid concentration of the aqueous phase has been determined for both complex-forming agents. (auth)

8307
SOLVENT EXTRACTION OF POLONIUM FROM NITRIC ACID SOLUTIONS. J. Danon and A. A. L. Zamith (Escola Nacional de Quimica, Rio de Janeiro). Nature 177, 746-7 (1956) Apr. 21.
The solvent extraction of trace Po in HNO_3 solutions by organic solvents was investigated. Peroxide-containing ether extracts ~65% of Po present from 8M HNO_3 solutions; peroxide-free ether extracts Po from HNO_3 solutions containing reducing agents. (C.W.H.)

5880 LMFP/P-9
[Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England].
THE EVAPORATION OF POLONIUM FROM BISMUTH MELTS. K. W. Bagnall and D. S. Robertson. [1956]. 2p.
The rate of evaporation of Po from Bi melts is calculated from experimental data. (T.R.H.)

POLONIUM 2.35

POLONIUM. Ed. by Harvey V. Moyer. (U. S. Atomic Energy Commission. TID-5221) 1956. 392 p. Available from Office of Technical Services, Department of Commerce, Washington 25, D. C. $1.75.

A review of the polonium project of the Manhattan Engineering District and the Atomic Energy Commission, including studies of the properties of polonium, its processing, instrumentation and waste disposal.

11691 NAA-SR-Memo-746
North American Aviation, Inc., [Downey, Calif.].
EXTRACTION OF POLONIUM FROM MOLTEN BISMUTH WITH FUSED SODIUM HYDROXIDE. Rex A. Barney. July 20, 1953. Decl. Nov. 6, 1958. 3p. $1.80 (ph), $1.80(mf) OTS.

Experimental data show that tracer polonium can be quantitatively separated from bismuth at 500°C. The process is applicable to a reactor using bismuth as a coolant. At the end of a run the sodium hydroxide and bismuth are separated and the polonium determined from the alpha activity. The results of several runs are tabulated. (J.E.D.)

19985 MLM-M-167
Monsanto Chemical Co., Dayton, Ohio.
THE TELLURIUM PROCESS: I. APPLICATION TO SOLUTIONS OF BOMBARDED BISMUTH. II. APPLICATION TO EXTRACTS OF RESIDUES FROM RADIOACTIVE LEAD DIOXIDE. Final Report No. 36. C. L. Rollinson, P. M. Hamilton, and J. W. Schulte. June 26, 1947. Decl. July 14, 1959. 114p. $18.30(ph), $6.00 (mf) OTS.

Processes for obtaining Po concentrates suitable for electrodeposition from aqua regia solutions of Po and Bi were investigated. The steps of the process include denitration with formaldehyde, coprecipitation of Te and Po by reduction with stannous chloride, separation of Ag as Ag ammine ion, separation of Te by reduction with N_2H_4, and conversion of the resulting HCl solution of Po to a HNO_3 concentrate. Application of the process to extracts of radioactive PbO_2 residues is also described. (J.R.D.)

PRASEODYMIUM 2.36

See also, this section,

RARE EARTHS (2.39).

PRECIPITATION 2.37

20989 DP-347
Du Pont de Nemours (E.I.) & Co. Savannah River Lab., Aiken, S. C.
MANGANESE DIOXIDE PRECIPITATION IN URANIUM-ALUMINUM NITRATE SOLUTIONS. Hugh E. Henry. Feb. 1959. Decl. Sept. 4, 1959. 12p. Contract AT(07-2)-1. $3.30(ph), $2.40(mf) OTS.

Precipitation of MnO_2 in solutions of U–Al alloy effected maximum removal of fission products when the alloy solutions were acid deficient. Minimum adsorption of U and minimum volume of centrifuged MnO_2 were obtained by precipitation in acidic solutions with vigorous agitation. (auth)

THE REMOVAL OF FISSION PRODUCTS FROM SOLUTION WITH A PRECIPITATOR-COLUMN TREATMENT. PART I. LABORATORY TRIALS. K. G. Seedhouse, J. Monahan, and G. Wallis. 1958. 36p. (AERE-ES/R-2220)

A synthetic effluent was treated in a Sludge Blanket Precipitator with 80 ppm PO_4, 40 ppm Fe^{3+}, at a pH of 11.5, being then passed through soil columns to achieve further activity removal. The decontamination in the Precipitator was 95 to 96%, the remaining activity consisting of 40% Ru and 60% Cs. All the Cs, and most of the Ru was removed in the columns, resulting in over 99% over-all removal of all the radioactivity. By employing long columns or columns in series, a decontamination factor of 10^3 can be achieved. Serious defects were observed with Nuneham Courtenay Greensand. These can partly be remedied by conditioning with polyelectrolytes, quaternary ammonium compounds, and silicones. Vermiculite is to be tested as an alternative column adsorbent, its properties appearing to be ideal. Tests which are being made on the use of two precipitators, the second one employing a ferrous sulfide 'blanket' to remove Ru, are giving very promising results.

PRECIPITATION 2.37

THE REMOVAL OF FISSION PRODUCTS FROM SOLUTION WITH A PRECIPITATOR-COLUMN TREATMENT. PART 2. PILOT PLANT TRIALS. K. G. Seedhouse, J. Monahan, K. W. Pearce, and G. Wallis. Jan. 1957. 22p. (AERE-ES/R-2089)

Part 1 issued as FPSD/P-13.

It has been found possible, on a pilot plant scale, to obtain a decontamination factor of 600 to 1,000 on a synthetic effluent. The process consists of treatment in a Sludge Blanket Precipitator with 80 ppm PO_4, 40 ppm Fe^{3+} at a pH of 11.5 followed by another precipitation at the same pH, using 20 ppm Fe^{2+} and 20 ppm S^{2-}. The effluent is finally passed through a column of Crude Vermiculite. The phosphate treatment removed 94% of the activity. This was increased to 98 to 99% by the sulfide precipitation. The chief effect of the sulfide treatment is to remove most of the radiocolloids, especially of Ce. The over-all decontaminations would not be greatly reduced if the sulfide precipitation was omitted, but it acts as a safeguard in case of difficulties in the column treatment.

98

METHODS FOR DETERMINATION OF THE MECHANISM OF CO-PRECIPITATION OF RADIOELEMENTS WITH THE PRECIPITATIONS OF SLIGHTLY SOLUBLE SALTS. A. P. Ratner. Zhur. Obshcheĭ Khim. 26, 949-51(1956) Apr. (In Russian)

The primary and secondary adsorptions produced by multi-valent ions were differentiated and calculated. The method did not lead to the separate analysis of the primary adsorption from intercrystallization. The relation of the adsorption magnitude to the concentration of its own ions permitted differentiation of various types of adsorptions. (R.V.J.)

9530

PRECIPITATION OF VANADIUM OXIDES. J. Halpern and F. A. Forward (to U. S. Atomic Energy Commission). U. S. Patent 2,665,970. Jan. 12, 1954.

A method for the recovery of V^{5+} from basic or neutral solutions is given. The solution is treated with gaseous molecular hydrogen, under pressure, and in the presence of a Ni or Pt hydrogenation catalyst. The H_2 reduces the V to a lower valent state, in which form it is insoluble in the solution, and the V then precipitates and is separated. (auth)

8436 BNL-3472

Brookhaven National Lab., Upton, N. Y.

FRACTIONAL PRECIPITATION PROCESSES FOR LIQUID METAL FUELS. Robert J. Teitel. [195?]. 21p. $0.75 (OTS).

Several liquid metal fuels based upon U-Bi, U-Pb-Bi, U-Pb-Sn, and U-Pb-Bi-Sn alloy systems have been proposed for reactor design. Experimental data on the distribution of rare earth tracers between precipitated uranium inter-metallic compounds and their liquid phases are reported and discussed. A complete processing cycle is proposed and tested experimentally for the U-Sn, in Pb-Bi-Sn dispersion fuel systems. (auth)

0470 A/CONF.15/P/2295

ISOLATION OF RADIOACTIVE FISSION ELEMENTS. N. E. Brezhneva, V. I. Levin, G. V. Korpusov, N. M. Manko, and E. K. Bogachova (U.S.S.R.). 42p.

To achieve group separation of radioactive fission fragments, the calcium oxalate precipitate was used with which radioactive strontium and rare earths co-precipitate. To ensure complete precipitation of strontium and rare earths that submit to different coprecipitation laws, a precipitation procedure was developed by which 98% of rare earths and strontium can be simultaneously separated on the precipitate, while zirconium, niobium, and ruthenium remain in solution. The calcium oxalate precipitate cleaned from impurities by washing is dissolved in nitric acid and used as a raw material for separation of Sr, Ce, Y, Pr, Nd, Pm, and Eu. (auth)

Decontamination of Radioactively Contaminated Aqueous Solutions. Charles S. Lowe (to the United States of America, as represented by the Atomic Energy Commission) U.S. 2,766,204, Nov. 27, 1956.

Radioactive aq. waste solns. are freed of fission products by pptn. of FeS at pH 4, filtration, pptn. of $Ca_3(PO_4)_2$ and $Fe(OH)_2$ at ph 10, and filtration. Removal of Ru is achieved by addn. of 10% by vol. NaOCl, heating to boiling, cooling to room temp., and then repeating the FeS, $Ca_3(PO_4)_2$-$Fe(OH)_2$cycle. At least 0.5 mg. of Fe^{++} per ml. and 0.15 mg. of phosphate ion per ml. should be present prior to pptn. HNO_3 and solid NaOH are used for pH adjustment. A decontamination factor of 10^3 is obtained in the 1st cycle, 10^4 in the 2nd cycle, and 10^5 in the 3rd cycle.

R. E. Druschel

PROTACTINIUM 2.38

1001

A MANGANESE-DIOXIDE PROCEDURE FOR ISOLATION AND CONCENTRATION OF PROTACTINIUM FROM IRRADIATED THORIUM COMPOUNDS. Leonard I. Katzin (Argonne National Lab., Lemont, Ill.) and Raymond W. Stoughton (Oak Ridge National Lab., Tenn.). J. Inorg. and Nuclear Chem. 3, 229-32(1956) Oct.

Traces of Pa may be coprecipitated on MnO_2 with good recovery from solutions 1N to 4N in HNO_3 upon precipitating 1.5 g of dioxide/l. by the addition of $KMnO_4$ to manganous nitrate in excess. Good separation is obtained from macro concentrations of $Th(NO_3)_4$. In concentrations up to 0.65M the Th does not interfere with the precipitation, while at twice this concentration definite interference is found owing to the effect on the physical properties of the solution. With the aid of NH_2OH to redissolve the dioxide, it is possible to concentrate the Pa with respect to carrier by a factor of 100 per cycle. Less satisfactory were H_2O_2, $NaNO_2$ and HCOOH. Simultaneous purification from Th and U may be achieved. Thorium is found to carry well in trace concentrations, but the effciency of this process falls off with increasing Th concentration. (auth)

11766

THE SEPARATION OF ZIRCONIUM AND PROTOACTINIUM BY AN ANION-EXCHANGE COLUMN. S. Kahn and D. E. Hawkinson (Tracerlab, Inc., Richmond, Calif.). J. Inorg. and Nuclear Chem. 3, 155-6(1956) Sept.

Separation of Zr and Pa with Dowex-1 is investigated. Results are reported as a plot of log distribution coefficient (K_d) vs. molarity of HCl. (T.R.H.)

11765

THE SOLVENT EXTRACTION OF PROTACTINIUM. A. Goble, J. Golden, and A. G. Maddock (Univ. Chemical Lab., Cambridge, England). Can J. Chem. 34, 284-92(1956) Mar.

The variation of the experimental extraction coefficient for protactinium upon dilution of the solvent ketone with benzene has been determined for aqueous solutions at constant concentration of hydrochloric acid. The bromo complex has been shown to be far less readily extracted. The effects on the extraction of the nitrate complex by amyl acetate, of the nitric acid, of the nitrate and hydrogen ion concentrations in the aqueous phase, as well as of the dilution of the solvent with benzene, have been explored. The existence of a slow reaction in the extraction has been demonstrated. It is concluded that chloride solutions are the more reliable for the isolation of protactinium from concentrates. (auth)

7587

THE SEPARATION OF PROTACTINIUM AND ZIRCONIUM BY AN ANION EXCHANGE COLUMN. A. G. Maddock and W. Pugh (The Univ. Chemical Labs., Cambridge, England). J. Inorg. and Nuclear Chem. 2, 114-17(1956) Feb.

Conditions for the separation of Zr and Pa by anionic exchange on an Amberlite IRA-400 resin column are described. The separation has been tested at mascroscopic concentrations of the elements. (auth)

5158 ORNL-330
Oak Ridge National Laboratory, Tenn.
CHEMISTRY OF PROTACTINIUM. V. SEPARATION OF THORIUM, PROTACTINIUM AND URANIUM WITH ANION EXCHANGE COLUMNS IN HCl SOLUTIONS. Kurt A. Kraus and George E. Moore. Apr. 27, 1949. Decl.Jan 12, 1956. 9p. Contract W-7405-eng.26.

PROTACTINIUM 2.38

1236

DETERMINATION OF PROTACTINIUM-233. F. L. Moore and S. A. Reynolds (Oak Ridge National Lab., Tenn.). Anal. Chem. 29, 1596-9(1957) Nov.

A liquid-liquid extraction system using diisobutylcarbinol as the organic phase is basis for a simple, rapid, control-type method for separation of Pa^{233}. Extraction is made from 6M hydrochloric acid–4% oxalic acid to inhibit extraction of Nb^{95}. If sample contains thorium, an extraction is first made without oxalic acid. (auth)

9534

PROTACTINIUM EXTRACTION PROCESS. D. F. Peppard (to U. S. Atomic Energy Commission). U. S. Patent 2,789,878. Apr. 23, 1957.

A method for the recovery of Pa from aqueous solutions is given, and its separation from U and Th is described. This separation is effected by organic solvent extraction using an alkyl phosphate, preferably TBP. Acidity of the aqueous solution is manipulated in order to separate the Pa, Th, and U singly and in combination, and salting out agents are used. (auth)

..126

THE CONCENTRATION OF PROTACTINIUM BY RECYCLING THROUGH AN ANION-EXCHANGE COLUMN. M. K. Barnett (Mound Lab., Miamisburg, Ohio). J. Inorg. and Nuclear Chem. 4, 358-66(1957).

Protactinium was separated from major impurities by sorption on an anion-exchange resin from strong HCl, followed by washing with the acid and elution with a mixture of HCl and HF. The gamma activity of the isotope (Pa^{231}) provided an adequate analytical procedure. Addition of either $AlCl_3$ or H_3BO_3 to the elution effluent rendered the Pa resorbable by the resin. Re-elution of the Pa with mineral acids was slow, but the re-employment of the HCl-HF elutriant produced a marked concentration of the product. (auth)

SEPARATION OF URANYL NITRATE BY EXTRACTION. R. W. Stoughton and F. L. Steahly (to U. S. Atomic Energy Commission). U. S. Patent 2,849,283. Aug. 26, 1958.

A process is presented for obtaining U^{233} from solutions containing Pa^{233}. A carrier precipitate, such as MnO_2, is formed in such solutions and carries with it the Pa^{233} present. This precipitate is then dissolved in nitric acid and the solution is aged to allow decay of the Pa^{233} into U^{233}. After a sufficient length of time, the U^{233} bearing solution is made 2.5 to 4.5 Molar in manganese nitrate by addition thereof, and the solution is then treated with ether to obtain uranyl nitrate by solvent extraction techniques.

MANGANESE DIOXIDE METHOD FOR PREPARATION OF PROTACTINIUM. L. I. Katzin (to U. S. Atomic Energy Commission). U. S. Patent 2,847,273. Aug. 12, 1958.

A method of obtaining U^{233} is described. An aqueous solution of neutron irradiated thorium is treated by forming therein a precipitate of manganese dioxide which carries and thus separates the Pa^{233} from the solution. The carrier precipitate so formed is then dissolved in an acidic solution containing a reducing agent sufficiently electronegative to reduce the tetravalent manganese to the divalent state. Further purification of the Pa^{233} may be obtained by forming another manganese dioxide carrier precipitate and subsequently dissolving it. After a sufficient number of such cycles have brought the Pa^{233} to the desired purity, the solution is aged, allowing the formation of U^{233} by radioactive decay. A manganese dioxide precipitate is then formed in the U^{233} containing solution. This precipitate carries down any remaining Pa^{233} thus leaving the separated U^{233} in solution from which it may be easily recovered.

PRECIPITATION OF PROTACTINIUM. R. L. Moore (to U. S. Atomic Energy Commission). U. S. Patent 2,843,452. July 15, 1958.

An improvement in the separation of protactinium from aqueous nitric acid solutions is described. It covers the use of lead dioxide and tin dioxide as carrier precipitates for the protactinium. In carrying out the process, divalent lead or divalent tin is added to the solution and oxidized, causing formation of a carrier precipitate of lead dioxide or stannic oxide, respectively.

PROTACTINIUM 2.38

14396

SEPARATING PROTOACTINIUM WITH MANGANESE DIOXIDE. G. T. Seaborg, J. W. Gofman, and R. W. Stoughton (to U. S. Atomic Energy Commission). U. S. Patent 2,831,750. Apr. 22, 1958.

The preparation of U^{233} and an improved method for isolating Pa^{233} from foreign products present in neutron-irradiated thorium is described. The method comprises forming a solution of neutron-irradiated thorium together with a manganous salt, then adding potassium permanganate to precipitate the manganese as manganese dioxide whereby protoactinium is carried down with the manganese dioxide dissolving the precipitate, adding a soluble zirconium salt, and adding phosphate ion to precipitate zirconium phosphate whereby protoactinium is then carried down with the zirconium phosphate to effect a further concentration.

13836

A NEW METHOD FOR THE RADIOCHEMICAL PURIFICATION OF PROTACTINIUM. I. E. Starik and L. D. Sheidina. Zhur. Neorg. Khim. 3, 139-44(1958). (In Russian)

An investigation was made to find a simple method for the radiochemical purification of Pa without the use of hydrofluoric acid. Precipitation with phthalic acid, phenylarsonic acid, and mandelic acid was tested. The first two reagents coprecipitate polonium. Mandelic acid allows a rapid and accurate determination with a precision of 5 to 10%. The precipitation with mandelic acid also assures a high degree of purity of Pa from all other radioisotopes. (J.S.R.)

17006

PROTACTINIUM. III. SOLVENT EXTRACTION FROM HALIDE SOLUTIONS. A. G. Goble and A. G. Maddock (University Chemical Lab., Cambridge, Eng.). J. Inorg. & Nuclear Chem. 7, 94-112(1958) Aug.-Sept.

The extraction of protactinium from chloride solutions by a number of organic solvents has been investigated and the effects of the acidity and chloride concentrations in the aqueous phase measured. It is shown that these and other results can be explained in terms of the distribution between the two phases of an ion-pair complex formed by a chloro-anion containing the metal and an onium cation containing water and solvent molecules. The extracting power of the solvent therefore depends on its base strength, or ability to form the cationic complex, as well as its dielectric constant. Dissociation or association of the ion-pairs may become important in the organic phase, so that departures from a simple distribution law may be found at some concentrations of the extracting metal. These departures can be correlated with the dielectric constant of the solvent. The effect on the extraction of strong acids, such as perchloric acid, and the use of solutions of the higher amines in benzene and benzonitrile are explained in terms of this model. Extraction from sulfate and thiocyanate solutions has also been investigated. (auth)

2489

CATION EXCHANGE METHOD FOR THE RECOVERY OF PROTACTINIUM. M. H. Studier and J. C. Sullivan (to U. S. Atomic Energy Commission). U. S. Patent 2,894,807. July 14, 1959.

A cation exchange process is described for separating protactinium values from thorium values whereby they are initially adsorbed together from an aqueous 0.1 to 2 N hydrochloric acid on a cation exchange resin in a column. Then selectively eluting the thorium by an ammonium sulfate solution and subsequently eluting the protactinium by an oxalate solution.

2497

SEPARATION PROCESS FOR PROTACTINIUM AND COMPOUNDS THEREOF. A. Van Winkle (to U. S. Atomic Energy Commission). U. S. Patent 2,895,791. July 21, 1959.

The separation of protactinium from aqueous solutions from its mixtures with thorium, uranium and fission products is described. The process for the separation comprises preparing an ion nitric acid solution containing protactinium in the pentavalent state and contacting the solution with a fluorinated beta diketone, such as trifluoroacetylacetone, either alone or as an organic solvent solution to form a pentavalent protactinium chelate compound. When the organic solvent is present the chelate compound is extracted; otherwise it is separated by filtration.

PROTACTINIUM 2.38

2485

PROCESS FOR CONTINUOUSLY SEPARATING IRRADIATION PRODUCTS OF THORIUM. L. P. Hatch, F. T. Miles, T. V. Sheehan, R. H. Wiswall, and R. J. Heus (to U. S. Atomic Energy Commission). U. S. Patent 2,893,936. July 7, 1959.

A method is presented for separating uranium-233 and protactinium from thorium-232 containing compositions which comprises irradiating finely divided particles of said thorium with a neutron flux to form uranium-233 and protactinium, heating the neutron-irradiated composition in a fluorine and hydrogen atmosphere to form volatile fluorides of uranium and protactinium and thereafter separating said volatile fluorides from the thorium.

2488

RECOVERY OF PROTACTINIUM FROM AQUEOUS SOLUTIONS. R. E. Elson (to U. S. Atomic Energy Commission). U. S. Patent 2,894,806. July 14, 1959.

The recovery of fluoride complexed protactinium from aqueous acidic solutions by solvent extraction is described. Generally the process of the invention comprises mixing an aqueous solution containing protactinium in a complexed form with an organic solvent which is specific for protactinium, such as diisopropyl carbinol, then decomposing the protactinium complex by adjusting the acidity of the aqueous solution to between 0.3 to 0.9 M in hydrogen ion concentration, and introducing a source of aluminum ions in sufficient quantity to establish a concentration of 0.5 to 1.2 M aluminum ion, whereupon decomposition of the protactinium fluoride complex takes place and the protactinium ion is taken up by the organic solvent phase.

2482

SEPARATION OF PROTACTINIUM FROM CONTAMINANTS. J. G. Malm and S. Fried (to U. S. Atomic Energy Commission). U. S. Patent 2,893,825. July 7, 1959.

The separation of protactinium by volatilization method is described. According to the invention, neutron irradiated finely divided thorium is reacted with aluminum trichloride or a mixture of aluminum trichloride and chlorine gas at a temperature of preferably between about 200 and 400°C. Following the chlorinating step the protactinium chloride along with aluminum chloride is selectively distilled from the mixture at a temperature of approximately 100°C. The protactinium chloride may be recovered from the mixture by treatment with sodium hydroxide, which converts the aluminum chloride to a soluble salt and forms insoluble protactinium hydroxide.

Oak Ridge National Lab., Tenn.
EXTRACTION OF PROTACTINIUM WITH DIISOBUTYLCARBINOL. J. R. Oliver, J. R. Meriwether, and R. H. Rainey. April 15, 1959. 13p. Contract W-7405-eng-26. $0.50(OTS). ORNL-26

Conditions for extracting protactinium from solutions of irradiated thorium by diisobutylcarbinol (DIBC) (2,6-dimethyl-4-heptanol) were determined in laboratory tracer experiments. Protactinium was extracted from a solution containing 1.0 M thorium, 0.6 M $Al(NO_3)_3$, and 4.0 M HNO_3. Impurities were scrubbed from the organic phase with a solution containing 0.6 M $Al(NO_3)_3$ and 2.0 M HNO_3. Feed/organic/scrub volume ratios were 1/0.4/0.75; there were 4 extraction and 5 scrub stages. Protactinium was stripped from the organic with 1.0 M HNO_3 containing 0.05 M fluoride. The extraction was made at 50°C to decrease emulsion formation. Under these conditions more than 99.5% of the protactinium was extracted. Decontamination factors from uranium, thorium, zirconium-niobium, and the rare earths were 6×10^2, 6×10^4, 5×10^3, 2.5×10^2, and 4×10^3, respectively. (auth)

SOLVENT EXTRACTION FROM HALIDE SOLUTIONS. PART I. SYNERGISTIC BEHAVIOUR WITH MIXED SOLVENTS. A. G. Goble and A. G. Maddock (University Chemical Labs., Cambridge, Eng.). Trans. Faraday Soc. 55, 591-603(1959) Apr.

The extraction of protactinium from hydrochloric acid solution by a variety of two-component mixtures of solvents have been investigated, and the relation between the extraction and the composition of the mixed solvent determined. While in some systems one of the solvents appeared to behave as an inert diluent, in others the mixture extracted much more than either pure solvent. The interpretation of the behavior of the latter group of mixtures is discussed. (auth)

15093

PAPER ELECTROPHORESIS OF PROTACTINIUM(V). Jacques Vernois (Institut du Radium, Paris). J. Chromatog. 2, 155-61(1959) Mar. (In French)

The electrophoretic behavior of Pa(V), Fe(III), U(VI), Pb(IV), Bi(III), Zr(IV), Ta(V), Nb(V), Th(IV), Ti(IV), and Po(III) in HCl and HCl–HF was studied. In these media protactinium can be separated from some of the above-mentioned elements. (auth)

PROTACTINIUM 2.38

RECOVERY OF PROTACTINIUM. (to United Kingdom Atomic Energy Authority). British Patent 810,542. Mar. 18, 1959.

Recovery of Pa from irradiated Th is described. The Th is dissolved in HNO_3 and, if necessary, the Pa is carried down in repeated MnO_2 precipitations. The Pa solution thus obtained or the crude HNO_3 solution is passed over phenol-formaldehyde resin on which the Pa is adsorbed. The Pa is eluted from the resin with NH_4F or HF aqueous solution. (T.R.H.)

RECOVERY OF PROTACTINIUM. K. A. Kraus and G. E. Moore (to U. S. Atomic Energy Commission). U. S. Patent 2,872,284. Feb. 3, 1959.

A process is presented for the separation of protactinium values from an aqueous solution containing Pa and Th values comprising establishing in the solution a HCl concentration of from 4 to 11 molar, contacting the resulting solution with an anion-exchange adsorbent, such as a polystyrene divinyl benzene polymer with quaternary amines as the active exchange group, to effect the adsorption of Pa values upon the adsorbent while leaving Th values in the solution, and then washing the separated Pa bearing adsorbent with an aqueous solution of HCl of less than 4M to exclusively elute Pa values from the adsorbent. If hexavalent U values are contained in the original solution they are adsorbed on the resin together with Pa. A separation is effected chromatographically by percolating the resin with aqueous HCl.

RARE EARTHS - General 2.39.01

14309

THE EFFECT OF SULFATE ION ON THE CRYSTAL SIZE OF PRECIPITATED RARE EARTH OXALATES. A. Glasner, M. Steinberg, and E. Levy (Hebrew Univ., Jerusalem). Chemist Analyst 48, 37-8(1959) June.

In separating rare earths from other cations in the form of insoluble oxalates, it was found that well grown crystals were precipitated from solutions due to the effect of the sulfate ion. It is pointed out that the precipitate from HNO_3 solution is a collection of aggregates of small crystals, while those obtained from the sulfuric acid solution are well grown with clearly discernible crystalline form. (J.R.D.)

RARE EARTHS - General 2.39.01

15102

THE COPRECIPITATION OF RARE EARTHS WITH CALCIUM OXALATE. B. C. Purkayastha and S. N. Bhattacharyya (Inst. of Nuclear Physics, Calcutta). J. Inorg. & Nuclear Chem. 10, 103-9(1959) Apr.

The mechanism of the uptake of rare earths by calcium oxalate was studied in detail. Yttrium-91, Eu^{152}, and Eu^{154} were used to obtain evidence of mixed crystal formation. It was found that, out of the three hydrates of calcium oxalate claimed by earlier workers, it is calcium oxalate dihydrate which carries rare earths through mixed crystal formation. The uptake of rare earths by calcium oxalate monohydrate follows a Freundlich adsorption isotherm. (auth)

SEPARATION OF METAL SALTS BY ADSORPTION. D. M. Gruen (to U. S. Atomic Energy Commission). U. S. Patent 2,869,983. Jan. 20, 1959.

It has been found that certain metal salts, particularly the halides of iron, cobalt, nickel, and the actinide metals, are readily absorbed on aluminum oxide, while certain other salts, particularly rare earth metal halides, are not so absorbed. Use is made of this discovery to separate uranium from the rare earths. The metal salts are first dissolved in a molten mixture of alkali metal nitrates, e.g., the eutectic mixture of lithium nitrate and potassium nitrate, and then the molten salt solution is contacted with alumina, either by slurrying or by passing the salt solution through an absorption tower. The process is particularly valuable for the separation of actinides from lanthanum-group rare earths.

19942

REDKOZEMEL'NYYE ELEMENTY; POLUCHENIYE, ANALIZ, PRIMENENIYE. (Rare Earth Elements; Extraction, Analysis and Application). D. I. Ryabchikov, I. P. Alimarin, I. N. Zaozerskii, R. V. Koglyarov, V. I. Kuznetsov, M. M. Senyavin, and Yu. S. Sklyarenko, eds. Moscow, Izd-vo AN SSSR, 1958. 331p.

Reports presented at the June 1956 Conference on Rare Earth Elements at the Institute of Geochemistry and Analytical Chemistry of the Academy of Sciences USSR were collected. The articles treat chemical methods of separating rare earth mixtures, methods of processing rare earth ores, ion exchange chromatography, chemical analysis, and some industrial applications of rare earths. (auth)

RARE EARTHS- Ion Exchange 2.39.02

MASS PRODUCTION OF PURE RARE EARTHS. R. A. Labine. Chem. Eng. 66, 104-7(1959) July 27.

A discussion of the ion exchange process for extraction of rare earth mixtures now used by Michigan Chemical Corp. is given. A flowsheet is presented showing process setup and arrangement. (C.J.G.)

16018

THE SEPARATION OF RARE EARTHS BY ION EXCHANGE. J. E. Powell and F. H. Spedding (Iowa State Coll., Ames). Trans. Met. Soc. AIME 215, 457-63(1959) June.

A complete review of the use of chelating agents in the separation of rare earths by ion exchange is given as well as a concise description of the recent pilot-plant operations of the Ames Laboratory. The two chelating agents which show the greatest promise are ethylenediamine-N,N,N',N'-tetraacetic acid and N'-(2-hydroxyethyl)ethylenediamine-N,N,N'-triacetic acid. (auth)

10911

SEPARATION OF METAL IONS BY MEANS OF ION EXCHANGE MEMBRANES. I. SEPARATION OF RARE EARTH MIXTURES, AND OF THORIUM-RARE EARTH MIXTURES USING ETHYLENEDIAMINETETRAACETIC ACID. K. Bril, S. Bril, and P. Krumholz (Research Lab. of Orquima S. A., São Paulo, Brazil). J. Phys. Chem. 63, 256-9(1959) Feb.

A method of separation of metal ions by electromigration in partially complexed solutions is described. The method makes use of ion-exchange membranes. Ethylenediaminetetraacetic acid is used as the complexing agent. Good separations are obtained in mixtures of lanthanum, praseodymium, and neodymium as well as of thorium and neodymium. The separation is affected by the nature of the accompanying anions. The influence of perchlorate, chloride, nitrate, and acetate is studied. (auth)

SEPARATION OF IRON FROM RARE EARTHS. J. H. Krěpelka, K. Vetejška, and J. Mazáček (Inst. für Erzforschung, Prague). Collection Czechoslov. Chem. Communs. 24, 198-202(1959) Jan. (In German)

The possibility of a simple separation of iron from rare earths on the strongly basic ion exchanger OAL was investigated. In hydrogen chloride medium, the rare earths are generally not bound as iron is. The iron can be eluted with water and determined in the usual manner. The method can be used for the separation of iron from rare earths as well as for the determination of iron in rare earths. (tr-auth)

ANION-EXCHANGE STUDIES. XXV. THE RARE EARTHS IN NITRATE SOLUTIONS. Y. Marcus and Frederick Nelson (Oak Ridge National Lab., Tenn.). J. Phys. Chem. 63, 77-9(1959) Jan.

Adsorbabilities of several rare earths—La, Ce, Pr, Nd, Pm, Sm, Eu, Tb and Yb—in slightly acidified lithium nitrate solutions have been investigated with a strong base anion-exchange resin. Adsorbabilities increase with increasing lithium nitrate concentration, and the lighter rare earths are more strongly adsorbed than the heavier. Sufficient differences in adsorbabilities were found to permit separation of the lighter rare earths with relatively short columns. (auth)

14236 NP-7536

Canada. Dept. of Mines and Technical Surveys. Mines Branch.

STUDIES ON THE SEPARATION OF THE RARE EARTHS FROM THORIUM IN SULPHATE SOLUTIONS, USING CATION EXCHANGE RESINS. D. C. Lewis and J. C. Ingles. Oct. 6, 1958. 45p. (R-31).

An ion exchange method for the sepration of the rare earth elements from thorium has been investigated. The method is based on the difference in the extent of complexing of the metal ions by sulfate ions in aqueous solution. Variables investigated were: sulfate concentration, nature of the counter-ion (i.e., the cation whose sulfate salt supplies the sulfate for complexing), and resin type. Separation was not quantitative but it was found possible to obtain reasonable recoveries of thorium free of rare earths. The application of the law of mass action to the solution and resin equilibria was undertaken in an attempt to explain the data. The theoretical expression obtained was not, however, in complete agreement with the experimental results.

7733

USE OF C-300 SYNTHETIC RESIN FOR RARE EARTHS SEPARATION. E. Lazzarini, R. Somigliana, and E. Zamorani. Energia nucleare (Milan) 5, 199-202(1958) Mar.

The possibility of using C-300 ion-exchange resin for the separation of rare earths was investigated. Trivalent thulium, terbium, and europium were the ions used in the tests. From the results obtained it was concluded that the C-300 resin can be used for the separation. The rare earths can be collected in pure form with only one cycle of elution using eluent of pH 3.1, 3.2, or even 3.3, if the atomic numbers of the rare earths differ by a few units. (J.S.R.)

RARE EARTHS- Ion Exchange 2.39.02

UTILIZATION OF COPPER AS A CATION EXCHANGER IN THE SEPARATION OF RARE EARTHS BY ION EXCHANGE BY MEANS OF ETHYLENEDIAMINE TETRA-ACETIC ACID. Jean Loriers and Claudine Lenoir. Compt. rend. 247, 468-71 (1958) July 28. (In French)

The use of copper in the ion exchange of rare earths permits the following improvements. The rare earths in complex solution with EDTA acid can be fixed selectively on a resin saturated with Cu^{2+} ions. Efficient separations were obtained with EDTA acid by means of a ring of Cu^{2+} in the columns. Solutions of copper salts of EDTA acid can be used as eluants. (tr-auth)

7134 ORNL-2252
Oak Ridge National Lab., Tenn.
PREPARATION OF FISSION RARE-EARTH ISOTOPES. R. S. Pressly. May 24, 1957. 14p. Contract W-7405-eng-26. $0.20(OTS).

The methods now used for the separation of the short-lived rare earths are described. The separation techniques have been improved to the point that a single ion exchange column can be used to separate the short-lived rare earths from each other and from the actinide elements which are present in the solution. This report also describes the process of separating the long-lived rare-earth group and the development work which has led to this process. Ion exchange has been used effectively in separating the individual long-lived rare earths from each other and from the actinide elements in small quantities. The Pm^{147} is now separated from Am^{241} by precipitating PmF_3 from 3.0M hydrofluosilicic acid, leaving americium complexed in solution. Americium and promethium are recovered, and larger quantities are handled. (auth)

6286
CONTROLLING RARE-EARTH SEPARATIONS BY MEANS OF VARYING RESIN COLUMN OPERATING TEMPERATURES. D. C. Stewart (Argonne National Lab., Lemont, Ill.). J. Inorg. and Nuclear Chem. 4, 131-3(1957) Mar.

11513
METHOD OF SEPARATING RARE EARTHS. F. H. Spedding et al. (to U. S. Atomic Energy Commission). U. S. Patent 2,798,789. July 9, 1957.

A method is given for the recovery of rare earths. The mixed rare earths are dissolved in an aqueous acid and NH_4OH is added to the solution until the pH is about 5 or greater. This solution of mixed rare earths is then contacted with a quantity of EDTA stoichiometrically insufficient to complex all of the rare earths present. The heavy rare earths form a more stable complex with EDTA than the lighter rare earths so the heavier rare earths will be preferentially complexed. The solution is then brought into contact with a cation exchange resin which adsorbs the uncomplexed rare earths, leaving as the first fraction the complexed rare earths dissolved in the aqueous medium. Additional fractions may be obtained by contacting the resin

250 CEA-913
France. Commissariat à l'Énergie Atomique, Paris.
CONTRIBUTION À L'ÉTUDE DE LA SÉPARATION DES TERRES RARES PAR ÉCHANGE D'IONS À L'AIDE DE LACTATE D'AMMONIUM. (Contribution to the Study of Rare Earth Separation by Ion Exchange Using Ammonium Lactate). I. Gratot. 1958. 19p.

Using chromatography on a column of Dowex 50 resin heated to 87°C, the separation of rare earths (from holmium to praseodymium) which may be produced with the cyclotron by heavy ions, α or protons was studied. From an ammonium lactate solution M at pH5, separations are carried out by varying the dilution as a function of the quantity of the target rare earth and of its position during elution. When weighable quantities of the rare earth (more than 5 mg) appear towards the end of the elution, the separation is little affected – this case approaches that of a tracer mixture of rare earths; if on the other hand weighable quantities of the rare earth are washed through at the beginning of the chromatogram, the dilution must be adjusted in order to obtain a good separation. (auth)

RARE EARTHS - Ion Exchange 2.39.02

9263
SEPARATION OF Te, Ru, Cs AND RARE EARTHS FROM ONE ANOTHER, USING ANION EXCHANGE RESIN DOWEX-1. Milenko V. Šušić. Bull. Inst. Nuclear Sci. "Boris Kidrich" (Belgrade) 7, 39-41(1957) Mar.

The separation of Te, Ru, Cs, and rare earths from one another, using the anion exchange resin Dowex-1 is studied. The behavior of each of the elements in alkaline medium is different. Tellurium, Cs, and Ru do not precipitate, while rare earths form sparingly soluble hydroxides. Rare earths can be separated from other elements by filtration. The solution containing the remaining elements is passed through the column. Tellurium and Ru are adsorbed in the column, Cs and trace quantities of rare earths pass through it. (auth)

9696 NP-7335
Rio de Janeiro. Centro Brasileiro de Pesquisas Físicas.
ANION-EXCHANGE STUDIES WITH ACTINIUM AND LANTHANIDES IN NITRATE SOLUTIONS. J. Danon. 1958. 7p. (Notas de Física Vol. IV, No. 15).

The anion exchange of Ac in trace quantities from its homolog La were studied. Experimental procedures are described, and results are discussed. It is suggested that the solubility of the double nitrates may be correlated with the adsorption of the lanthanides by resin. Thus, the solubility increases in the order La < Ce < Pr < Nd < Sm, which is the reverse of the adsorption of these elements by the resin. If adsorption by the anion exchange resin is determined by the stability of nitrate complexes, the solubility of the double nitrates of La and Ac decrease with the increase in the tendency toward the formation of nitrate complexes in the series. (J.R.D.)

7183 AERE-C/R-2277
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
FISSION PRODUCT SEPARATION BY ION-EXCHANGE. F. Morgan and M. L. Sizeland. 1957. Date of MS. 1952. Decl. Apr. 1957. 19p. $0.54(BIS).

A remote-control apparatus has been built and operated for the separation and concentration of the major long-lived fission products by ion exchange: operating details and desirable improvements are given. Factors governing the ion exchange separation of the rare earths are discussed and illustrated. (auth)

5249
ION-EXCHANGE STUDY OF THIOCYANATE COMPLEXES OF THE ACTINIDES AND LANTHANIDES. J. P. Surls, Jr. and G. R. Choppin (Univ. of California, Berkeley). J. Inorg. and Nuclear Chem. 4, 62-73(1957) Feb.

The ion-exchange behavior of many tripositive actinides and lanthanides and yttrium from Dowex-1 anion-exchange resin with ammonium thiocyanate solutions has been studied. Lanthanides and yttrium elute sooner than actinides under all conditions studied. Neither lanthanides nor actinides showed a simple elution sequence of the members within the series. On elution from Dowex-50 with ammonium thiocyanate, the actinides eluted in the usual sequence of decreasing atomic number. The lanthanides studied also exhibited the usual elution sequence from Dowex-50; however, the actinides eluted sooner than the lanthanides of comparable ionic radius, indicating stronger complexing of actinides with thiocyanate. (auth)

8665 IGRL-T/R-81
THE SEPARATION OF RADIOACTIVE RARE-EARTH ELEMENTS BY ION-EXCHANGE. B. K. Preobrazhenskii (Preobrazhensky), A. V. Kalyamin, and O. M. Lilova. Translated by E. G. Peters (U.K.A.E.A., Risley) from Zhur. Neorg. Khim. 2, 1164-6(1957). 6p.

The possibility of using home-produced KU-2 cation resin for the rapid separation of radioactive rare-earth elements in small columns has been proven. Equilibrium is attained on KU-2X6 resin several times faster than on Bowex-50X12, and this enables more rapid separations. The separation of two elements, Lu and Yb, has been carried out in as little as five minutes. Good separation of Y and Dy has also been obtained. (auth)

SEPARATION OF YTTRIUM AND FISSION-PRODUCT RARE EARTHS BY ION EXCHANGE AT ROOM TEMPERATURE. E. J. Troianello and T. T. Sugihara. [1957]. 10p. (AECU-3807)

Determination of a large number of cross sections for the formation of Y and light rare earths in deuteron fission of U required a reliable chemical-separation method. In the method that has been used successfully, the separation is made using 8 to 15 mg of carriers on colloidal Dowex-50, eluting with 0.70M ammonium lactate, pH 3.30, at room temperature. Over-all chemical yields were regularly in the range of 60 to 85%, and adequate separation of adjacent rare earths was achieved. A disadvantage of the method is the relatively long time, about 35 hours, required for the elution through the Nd band.

RARE EARTHS - Ion Exchange 2.39.02

13807

THE CHROMATOGRAPHIC SEPARATION OF THE RADIOISOTOPES OF THE ELEMENTS OF RARE EARTHS BY MEANS OF ION EXCHANGE. A. K. Lavrukhina, F. I. Pavlotskaya, A. A. Pozdnyakov, and I. M. Grechishcheva. Zhur. Neorg. Khim. 3, 82-7(1958). (In Russian)

The chromatographic separation of rare earths formed by nuclear transformations with high-energy particles is discussed. Special attention is given to the effect of the quantity of the elements on the degree of separation and to the position of the maximum of the chromatographic curve. (J.S.R.)

13806

THE THEORY OF THE SEPARATION OF RARE EARTHS BY MEANS OF CHROMATOGRAPHICAL METHODS. N. N. Tunitskii, V. V. Nekrasov, and E. P. Cherneva. Zhur. Neorg. Khim. 3, 66-73(1958). (In Russian)

The results of the application of statistical methods to the theory of the separation of rare earths by chromatographic methods are described. Theoretical results are compared with experimental data. (J.S.R.)

9696 NP-7335

Rio de Janeiro. Centro Brasileiro de Pesquisas Físicas.

ANION-EXCHANGE STUDIES WITH ACTINIUM AND LANTHANIDES IN NITRATE SOLUTIONS. J. Danon. 1958. 7p. (Notas de Física Vol. IV, No. 15).

The anion exchange of Ac in trace quantities from its homolog La were studied. Experimental procedures are described, and results are discussed. It is suggested that the solubility of the double nitrates may be correlated with the adsorption of the lanthanides by resin. Thus, the solubility increases in the order La < Ce < Pr < Nd < Sm, which is the reverse of the adsorption of these elements by the resin. If adsorption by the anion exchange resin is determined by the stability of nitrate complexes, the solubility of the double nitrates of La and Ac decrease with the increase in the tendency toward the formation of nitrate complexes in the series. (J.R.D.)

1107 ISC-851

Ames Lab., Ames, Iowa.

QUANTITATIVE SEPARATION OF SMALL AMOUNTS OF RARE EARTHS FROM THORIUM, URANIUM, AND ZIRCONIUM BY ION EXCHANGE. Henry John Hettel and V. A. Fassel. Dec. 1956. 71p. Contract W-7405-eng-82. $2.00(OTS).

A successful method has been developed for the determination of certain rare earths in thorium in the fractional ppm range. The procedure is based on the ion-exchange chromatographic separation of the rare earths plus added yttrium carrier from the thorium, followed by emission spectrometric determination of the rare-earth impurities in the yttrium carrier. A simultaneous separation from the rare earths of the common element impurities present in the thorium has been accomplished. A high degree of compensation for procedural errors is achieved by the use of a pure rare earth as both the carrier in the separation and purification procedure and the matrix material in the spectrographic determination. The method fulfills the requirements of accuracy, sensitivity, and speed necessary for use in the routine analysis of reactor-grade thorium metal. It can find application, in its present form, also for the simultaneous determination of part-per-billion amounts of common element impurities in thorium. (auth)

PREPARATION OF RARE-EARTH CONCENTRATES. D. C. Stewart and J. P. Faris (Argonne National Lab., Lemont, Ill.). J. Inorg. and Nuclear Chem. 3, 64-6(1956) Aug.

An ion-exchange resin column was used to recover mixed yttrium-group rare earths and it was discovered that the method was effective for separations of rare earths. The acidified glycolic acid solution of rare earths is passed through a cation-exchange resin bed from which the rare earths are then stripped in several large cuts and precipitated with NH_4OH or NaOH. The cuts varied widely in rare earth composition and the separations effected, though crude, should be useful in producing concentrates well suited for final separations and purifications. (T.R.H.)

RARE EARTHS - Ion Exchange 2.39.02

11138
PAPER CHROMATOGRAPHY OF INORGANIC IONS. XIII. THE SEPARATION OF NON-COMPLEXED RARE EARTH IONS. Michael Lederer (Institut du Radium, Paris). Anal. Chim. Acta 15, 46-50(1956) July.

The sequence of the rare earth chlorides in paper chromatography with mixtures of ethanol or acetone and aqueous HCl was established. A certain number of rare earth separations is possible. (auth)

1755 ISC-617
Ames Lab., Ames, Iowa.
BASIC PRINCIPLES INVOLVED IN THE MACRO-SEPARATION OF ADJACENT RARE EARTHS FROM EACH OTHER BY MEANS OF ION EXCHANGE. J. E. Powell and F. H. Spedding. Oct. 26, 1955. 28p. Contract W-7405-eng-82.

The separation of rare earth mixtures by ion exchange using ammonium ethylenediaminetetraacetate as an eluting agent and cupric ion as a retaining cation has been discussed in detail. Simple counter-current separation theory has been used to predict the minimum number of displacements of an adsorbed band that are necessary in order to separate the components of a binary mixture. It has been shown how the theory can be applied to even more complex systems and experimental data have been presented for some of the more difficultly separable groups of rare-earth species. (auth)

971 TIL/T4630
A CONTINUOUSLY FUNCTIONING AUTOMATIC APPARATUS FOR THE SEPARATION AND QUANTITATIVE DETERMINATION OF RARE EARTH ELEMENTS IN A MIXTURE, BY MEANS OF ION EXCHANGE RESINS. (Su Una Apparecchiatura a Funzionamento Continuo ed Automatico per la Separazione e per la Determinazione Quantitativa Degli Elementi Delle Terre Rare in Miscela, Mediante Resine Scambiatrici de Ioni). L. Mazza. Translated from Atti accad. nazl. Lincei Classe sci. fis. mat. e nat. (8), 11, 80-5(1951). 6p.

An abstract of this paper appears in Nuclear Science Abstracts as NSA 6-3545.

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6378 A/CONF.15/P/1568(Rev. 1)
SEPARATION OF TRACES OF RARE EARTH IN URANIUM BY IONIC EXCHANGE. Heriberto A. Braier (Comisión Nacional de Energía Atómica, Buenos Aires). 8p.

A solution of uranyl ion, with traces of europium, in a sulfuric medium is passed through a bed of cationic resin, in such a way that the anionic complex of the uranyl is let through and the rare earth retained. The remainder of the uranium is washed with a sulfuric acid solution, and the rare earth is subjected to elution by hydrochloric acid. The final determination is made by spectrography. The fixation of europium by the resin and its subsequent elution is continued by adding Eu^{154}, which acts as a tracer. This method is promising for the determination of traces of the rare earths in Uranium because it is simpler than those described in the literature. (auth)

RARE EARTHS - Solvent Extraction 2.39.03

1591
SEPARATION OF YTTRIUM AND RARE-EARTH NITRATES WITH THE SOLVENT EXTRACTION SYSTEM-TRI-N-BUTYLAMINE-3 METHYL-2-BUTANONE. W. G. Gruzensky and G. T. Engel (U. S. Bureau of Mines, Albany, Ore.). Trans. Met. Soc. AIME 215, 738-42(1959) Oct.

The application of tri-n-butylamine as an extractant in separating yttrium-rare earth mixtures by liquid-liquid extraction is described. The method of opening the ore is related, followed by a description of the preliminary separation of the composite into groups. The different variables in an amine-ketone-yttrium-rare earth-nitrate system were studied. (auth)

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TRI-n-BUTYL PHOSPHATE AS AN EXTRACTING AGENT FOR INORGANIC NITRATES. VI. FURTHER RESULTS FOR THE RARE EARTH NITRATES. E. Hesford, E. E. Jackson, and H. A. C. McKay (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. & Nuclear Chem. 9, 279-89(1959) Mar.

Extraction of the higher lanthanide nitrates by tri-n-butyl phosphate (TBP) is generally similar to that of the lower lanthanides. However the trend of increasing extractability with atomic number in the lower sub-group (La–Gd) is not always continued in the higher sub-group (Gd–Lu). Moreover there is sometimes a slight discontinuity at the half-way point (Gd), and sometimes an appreciable difference between lanthanides of even and of odd atomic number. All the lanthanides appear to form tri-solvates $M(NO_3)_3 \cdot 3TBP$. (auth)

10245

SEPARATION OF SCANDIUM FROM AQUEOUS SOLUTIONS. D. F. Peppard and E. S. Nachtman (to U. S. Atomic Energy Commission). U. S. Patent 2,824,783. Feb. 25, 1958.

This patent relates to a process for the separation of scandium from yttrium, thorium, and trivalent rare earths and with their separation from each other. It has been found that scandium and yttrium can be separated from trivalent rare earths in acidic solution, for example, a solution 6 M in HCl, by contacting with tributyl phosphate, whereupon the scandium is preferentially extracted into the organic phase, leaving the yttrium and trivalent rare earths in the aqueous phase.

SEPARATION OF RARE EARTHS WITH THE USE ETHYLENEDIAMINE-TETRAACETIC ACID. VI. THE SYSTEM NH_4(Gd-EDTA)-NH_4(Y-EDTA)-H_2O AT 0°C. G. Brunisholz and M. Randin (Univ. of Lausanne, Switzerland). Helv. Chim. Acta 41, 195-9(1958). (In French)

Two stable solid phases appear in the system NH_4[Gd-EDTA]–NH_4[Y-EDTA]–H_2O at 0°C: the gadolinium-rich octahydrate NH_4[(Gd,Y)-EDTA], $8H_2O$ (= phase α) and the yttrium-rich hexahydrate NH_4[(Y,Gd)-EDTA], $6H_2O$ (= phase η). An important miscibility gap exists between the two phases. The phase α gives easily metastable solutions which are supersaturated with regard to phase η. The system belongs to the type IV of the classification of Roozeboom. (auth)

204

THE EXTRACTION OF THE SALICYLATES OF SCANDIUM, YTTRIUM, CERIUM, LANTHANUM, URANIUM, AND THORIUM. B. N. Sudarikov, V. A. Zaytsev, Yu. G. Puchkov. Nauch. Doklady Vysshei Shkoly. Khim. i Khim. Tekhnol., No. 1, 80-3(1959).

The work is an attempt to attain the separation of the elements mentioned by means of the extraction taking place with complex formation. The extraction was controlled by the radioactive isotopes Sc^{46}, Y^{90}, Ce^{141}, La^{140}, and Th^{234}. Salicylic acid was chosen because it easily forms complex compounds with metals and is readily soluble in organic solvents. Isoamyl alcohol was used as a solvent. The distribution coefficient α of salicylates between the aqueous and organic phase was checked in dependence on the pH of the solution. The following substances were quantitatively extracted: scandium salicylate at pH values between 3.3–5.5; yttrium salicylate at pH values higher than 4, lanthanum salicylate at pH values higher than 4.5; cerium salicylate at pH values higher than 5.0 and thorium salicylate at pH values higher than 3.0. Uranium salicylate was extracted between pH 2.5 to 5.5, with higher pH values; however, a crystalline precipitate is formed which was analyzed as $NH_4\ UO_2(HSal^-)_3 \cdot 4H_2O$. A straight line with the tangent of the inclination angle = 2 resulted from the coordinate system $lg(\alpha) - lg(H^+)$ with a constant salicylic acid concentration and from the system $lg(\alpha) - lg(HSal)_{org}$ at a constant pH = 2.2. Thus 2 H^+ ions are emitted in the reaction with salicylic acid. (TCO)

2403

THE USE OF DIOCTYL PHOSPHORIC ACID EXTRACTION IN THE ISOLATION OF CARRIER-FREE ^{90}Y, ^{140}La, ^{144}Ce, ^{143}Pr, AND ^{144}Pr. D. F. Peppard, G. W. Mason, and S. W. Moline (Argonne National Lab., Lemont, Ill.). J. Inorg. and Nuclear Chem. 5, 141-6(1957).

Tracer-level Ce has been oxidized to the tetravalent state and shown to be preferentially extracted from a 10M HNO_3 aqueous phase into a 0.75M, or 0.30M, solution of di(2-ethyl hexyl) orthophosphoric acid in n-heptane. In this system the ratio of the K for Ce(IV) to that for Ce(III) is greater than 10^6, and the K for Ce(IV) is much greater than that for any trivalent lanthanide. This system has been utilized to purify Ce^{144} with respect to lanthanide contaminants, including its Pr^{144} daughter, and to prepare a highly-purified gross sample of natural Ce for neutron bombardment in the preparation of Pr^{143}. It has been used also in the isolation of Pr^{143} and Pr^{144} products for tracer studies

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and for half-life determinations. A decontamination factor, with respect to the parent Ce^{144}, greater than 10^7 was obtained for a Pr^{144} sample isolated and prepared for counting in a period of less than 10 min. Other di(2-ethyl hexyl)-orthophosphoric acid systems employing dilute HCl or HNO_3 as the opposing phase have been used for separating Y^{90} from its Sr^{90} parent and for separating La^{140} from its Ba^{140} parent and from contaminant $Sr^{90}-Y^{90}$. Decontamination factors greater than 10^7 have been obtained in both separations, the total processing times being less than 15 min. The following new half-life values have been obtained: Y^{90}, 63.97 ± 0.1 hr; La^{140}, 40.27 ± 0.05 hr; Pr^{143}, 13.59 ± 0.04 day; and Pr^{144}, 17.27 ± 0.04 min. (auth)

11117

FRACTIONAL EXTRACTION OF THE LANTHANIDES AS THEIR DI-ALKYL ORTHOPHOSPHATES. D. F. Peppard, G. W. Mason, J. L. Maier, and W. J. Driscoll (Argonne National Lab., Lemont, Ill.). J. Inorg. and Nuclear Chem. 4, 334-43(1957).

The extraction of lanthanides(III) and yttrium(III) into a solution of di(2-ethyl hexyl) orthophosphoric acid (symbolized as HDEHP) in a carrier solvent from aqueous mineral acid phases has been investigated as a function of HDEHP concentration in the organic phase, mineral acid concentration in the aqueous phase, and Z, using the radioactive-tracer technique and employing americium as a normalizing element. The distribution ratio, K, defined for a given radioactive nuclide as its concentration in the organic phase divided by its concentration in the aqueous phase, has been found to have a direct third-power dependency upon the HDEHP concentration in the organic phase and an inverse third-power dependency upon the mineral acid concentration in the aqueous phase. In experiments involving gross concentrations of extracting cation, it has been shown that none of the anion associated with this cation in the initial aqueous phase reports in the equilibrated organic phase. On the basis of these data, the extracting species has been formulated as $M(DEHP)_3$, possibly with solvate water. Operationally, HDEHP may be considered as the high-acid analogue of thenoyl trifluoroacetone (symbolized as HTTA); and analogously the $M(DEHP)_3$ is tentatively considered to be a chelate complex. A plot of log K vs. Z is well represented by a straight line of positive slope corresponding to an average value of r, defined as the ratio of K_{Z+1} to K_Z, of 2.5. This average r to 2.5, to be compared with the value of 1·63 as the ratio of molar aqueous solubilities of the dimethyl phosphates of adjacent lanthanides as reported by Marsh, is sufficiently large to make fractionation of lanthanides by liquid-liquid partition an attractive possibility. Successful application of such a technique to a gross sample has been demonstrated. In the plot of log K vs. Z, Y falls on the straight line if given an artificial Z approximately 67.6 as it does in Marsh's plot of log molar solubility vs. Z for the lanthanide dimethyl phosphates. (auth)

11115

TRI-n-BUTYL PHOSPHATE AS AN EXTRACTING SOLVENT FOR INORGANIC NITRATES. II. YTTRIUM AND THE LOWER LANTHANIDE NITRATES. D. Scargill, K. Alcock, J. M. Fletcher, E. Hesfor, and H. A. C. McKay (Atomic Energy Research Establishment, Harwell, Didcot, Berks). J. Inorg. and Nuclear Chem. 4, 304-14(1957).

Tri-n-butyl phosphate (TBP) can be used to extract and separate Y and the lower lanthanides (lanthanum-gadolinium). Extraction from HNO_3 solutions generally increases with acidity, sometimes very steeply, though there is often a region of falling partition coefficients between say 4 and 7 M HNO_3. Extraction at low acidity but high nitrate ion concentration (added, for example, as $NaNO_3$) is usually high. Extractability increases with atomic number in the lanthanide series, with Y more extractable than any lanthanide at acidities > ~5 M HNO_3, though less extractable at low acidities. The separation factors for successive lanthanides increase with acidity and reach values as high as 2. They are also high in systems of low acidity but high nitrate concentration, and in presence of TTA (thenoyltrifluoracetone) in the organic phase. Experiments at varying TBP concentrations indicate the formation of $Y(NO_3)_3 \cdot 3TBP$ and $Ce(NO_3)_3 \cdot 3TBP$. (auth)

2420 ISC-605

Ames Lab., Ames, Iowa.

QUARTERLY SUMMARY RESEARCH REPORT IN ENGINEERING FOR JANUARY, FEBRUARY, MARCH 1955. June 25, 1955. Decl. Jan. 6, 1956. 14p. Contract W-7405-eng-82. $3.30(ph OTS); $2.40(mf OTS).

Equilibrium data have been determined for the rare earth nitrate–water–nitric acid–TBP systems. The production of Zr by the reduction of ZrF_4 with Mg is being studied. The surface tension of Ce and La and their wetting of refractory oxides were investigated. The circulation of Bi–U alloys in the Th–Mg loop was described. (C.W.H.)

RARE EARTHS - Solvent Extraction 2.39.03

11111 ISC-766
Ames Lab., Ames, Iowa.
SOLVENT EXTRACTION EQUILIBRIA FOR RARE EARTH NITRATE–TRIBUTYL PHOSPHATE SYSTEMS. Lester L. Knapp, Morton Smutz, and F. H. Spedding. Aug. 1956. 44p. Contract W-7405-eng-82. $0.30(OTS).

Studies were made on the effect of process variables such as rare earth concentration, acid concentration, and salting-out agents on equilibrium data of the TBP–water–rare earth nitrate system. Distribution data were obtained for individual pure rare earths and Y in systems containing no HNO_3 or salting-out agents. The extractability of the pure rare earths was shown to increase with increasing atomic number up to a maximum at Dy and then to diminish with further increases in atomic number. Ytterbium does not follow the pattern set by the other rare earths. At low concentrations Yb was found to be the least extractable of the rare earths studied but at high concentrations appeared to be the most extractable. Yttrium behaved similarly to Yb. (auth)

3785 BMI-261
Battelle Memorial Inst., Columbus, Ohio.
DISTRIBUTION OF RARE-EARTH TRACERS BETWEEN AQUEOUS AND TRIBUTYL PHOSPHATE–DILUENT PHASES. Final Report. R. H. Blackmore, A. E. Bearse, and G. D. Calkins. June 20, 1952. Decl. Nov. 30, 1955. 25p. Contract AT-(30-1)-Gen-228. $0.25(OTS).

The purification of $Th(NO_3)_4$ by solvent extraction of rare-earth impurities is discussed. Data are presented on the effect of several variables on the distribution of rare e earths between aqueous and TBP–diluent phases. The distribution ratios (organic/aqueous) of the rare earths vary directly with tributyl phosphate (TBP) concentration of the organic phase and HNO_3 concentration, and inversely with Th concentration. (auth)

3483 CC-264
[Clinton Labs., Oak Ridge, Tenn.]
THE EXTRACTION METHOD OF PURIFICATION OF URANYL NITRATE. L. S. Myers, Jr., E. C. Anderson, Sol Wexler, and G. E. Boyd. Aug. 28, 1942. Decl. Dec. 13, 1955. 9p. (A-295). $1.80(ph OTS); $1.80(mf OTS).

Three extractions of a diethyl ether solution of uranyl nitrate with small portions of water are effective in removing rare earths, as is shown by radio-gadolinium and radio-europium tracer experiments. A study of representative ethers, alcohols, ketones, and esters showed that diethyl ether and a mixture of 85% ethyl methyl ketone with 15% xylene are the best solvents for the extractions. At 25°C a saturated diethyl ether solution is 1.8 molar, and a similar solution in the ketone-xylene mixture is 2.0 molar. An empirical relation for the distribution ratio between ether and water is $K = C_S/C_W^{3.3} = 0.20$ where C_S is the equilibrium concentration in the ether layer of the uranyl nitrate, and C_W that in water. A similar equation for the ketone-xylene mixture is $K = C_S/C_W^{1.24} = 0.60$. Di-ethyl ether gives the better extraction. Sodium chloride, sodium nitrate, and uranyl chloride have no deleterious effect on the extraction. However, more than four ml of nitric acid per hundred ml of saturated ether solution reduce the efficiency of the extraction ir removing UX. (auth)

RARE EARTHS - Other 2.39.04

See also, under PROCESS CHEMISTRY AND ENGINEERING, SPECIAL PROCESSES--Redox (6.17.19).

RARE EARTHS- Other 2.39.04

1465

EUROPIUM AND SAMARIUM REDUCTION. T. T. Campbell and F. E. Block (Bureau of Mines Experiment Station, Albany, Ore.). J. Metals 11, 744-6(1959) Nov.

High-purity europium and samarium metals were prepared by lanthanum and zirconium reduction of the oxides. High-purity europium was obtained with reduction temperatures as low as 900°C. Samarium metal was prepared in good yield by zirconium reduction of Sm_2O_3. Both cerium and aluminum reduced the samarium and europium oxides but were found to exert appreciable vapor pressure at operating temperatures and as a result tend to volatilize along with the samarium or europium metals. (C.J.G.)

APPLICATION OF CALCIUM FLUORIDE IN SEPARATION OF SIGNIFICANT QUANTITIES OF LANTHANIDES FROM PLUTONIUM. P. M. Aron. Atomnaya Energ. 5, 183-5(1958). (In Russian)

Coprecipitation of rare-earth elements, from Pu^{239} fission, with calcium fluoride was carried out in the presence of Ag_7NO_{11}. The segregation of lanthanides from plutonium by single coprecipitation with calcium fluoride can be improved by repeated precipitation of fluorides. Double precipitation leaves 99.92% of the initial quantity of plutonium in solution, while the residue retains practically the total activity related to europium. Coprecipitation of lanthanides with calcium fluorides in the presence of Ag_7NO_{11} can be used not only for mass spectroscopic determinations of fission fragment yields, but, in combination with precipitation of lanthanides with ferric hydroxide, followed by iron extraction with ether, the fluoride coprecipitation leads to lanthanide recovery from the irradiated plutonium without any macrocarrier. (R.V.J.)

1283

SEPARATION OF CERTAIN RARE EARTH ELEMENTS BY A DRY METHOD. APPLICATION TO SAMARIUM AND EUROPIUM. Jean-Claude Achard. Compt. rend. 245, 1064-6(1957) Sept. 23. (In French)

The results obtained for Sm and Eu are analogous to those for Yb previously reported. Work is described on the purification of Sm and Eu, separation of other rare earths, and preparation of the protoxides and corresponding metals. (T.R.H.)

10030

SEPARATION OF CERTAIN RARE-EARTH ELEMENTS BY A DRYING METHOD. APPLICATION TO YTTERBIUM. Jean-Claude Achard. Compt. rend. 244, 3059-62(1957) June 17. (In French)

The action of carbon, at high temperature and under pressure, on a mixture of rare earth oxides permits separation by distillation of Sm, Eu, and Yb. It is shown that Yb can be completely separated and recovered in a pure state, either metal or lower oxide. (tr-auth)

9713 AEC-tr-3600

SEPARATION OF THE YTTRIUM GROUP INTO SUBGROUPS ON THE BASIS OF A COMPLEX FORMER. N. S. Vagina. Translated by A. L. Monks (Oak Ridge National Lab.) from Zhur. Neorg. Khim. 2, 1522-7 (1957). 12p. $3.30(ph), $2.40(mf) JCL or LC.

The methods of separating cerium, based on the formation of compounds of high valency, were thoroughly developed. The few methods known for the separation of yttrium are very complex and lengthy, based on either a certain difference in the solubility of the simple yttrium and lanthanide compounds or on their different basicity. Recently, in the separation of the rare earth elements, methods were used which are based on complex-compounds which makes it possible to more clearly detect the individual nature of each element. Hence, for example, the fact of forming a complex yttrium fluoride in a fluoride melt of the alkaline metal points to a certain difference in the properties of yttrium from those of the lanthanides. (auth)

8349

EXTRACTION AND PURIFICATION ON AN INDUSTRIAL SCALE OF SAMARIUM AND EUROPIUM. Ch. de Rohden. Energie nucléaire 2, 21-8(1958) Jan.-Mar. (In French)

Samarium and europium both have a high neutron absorption cross section, which suggests their utilization for reactor control. Two apparatuses for continuous or semi-continuous production are described, one of which will produce 1 kg of samarium oxide and the other will produce 100 g of europium oxide. Both oxides have a purity of more than 99%. The apparatus can be enlarged or even doubled if the demand for the metals justifies it. (tr-auth)

RARE EARTHS - Other 2.39.04

9209

SEPARATION OF THE LANTHANONS AT AMALGAM CATHODES. II. THE SEPARATION OF SAMARIUM FROM GADOLINIUM AND PURIFICATION OF EUROPIUM AT A LITHIUM AMALGAM CATHODE. E. I. Onstott (Los Alamos Scientific Lab., N. Mex.). J. Am. Chem. Soc. 78, 2070-6(1956) May 20.

Samarium is efficiently separated from Gd by electrolysis of the citrate complexes at a Li amalgam cathode. Separation factors varying between 340 and 6220 were calculated. The separation can also be done in acid solution at a pH of about 5 with citrate absent. Data were obtained which show how the electrolysis is dependent on the cathode potential and the pH of the electrolyte. Lithium amalgam is shown to be superior to Na amalgam for the separation. It is shown that Eu is electrolyzed into a Li amalgam cathode at a rate approximately equal to that predicted when the parameters of electrolyte volume cathode area, and temperature are changed. Europium of better than 99.9% purity was isolated from Eu–Sm mixtures by proper control of the cathode potential. (auth)

9633 KLX-1704

Vitro Corp. of America, New York.

HOMOGENEOUS REACTOR FUEL REPROCESSING. Quarterly Progress Report No. 1 for the Period July 1–September 30, 1953. Job 87. Oct. 19, 1953. Decl. Feb. 27, 1957. 16p. For Oak Ridge National Lab. Contract W-7405-eng-26, Subcontract 535. $3.30(ph OTS); $2.40 (mf OTS).

In a study of solubilization conditions of rare-earth fluorides in 0.02M UO_2SO_4 at 100°C, it was found necessary to have about 0.3 g of residual fluoride per liter in solution to maintain the rare earth-fluorides insoluble. Tests are reported for rare-earth absorption by CaF_2 at 100°C, fused alundum pellets impregnated with 1% CaF_2, garnet minerals, Ca titano-silicate mineral, and a natural Ca Mg silicate (diopside). Treatment of effluent from a CaF_2-packed absorption column with stoichiometric Th ion plus 10% excess reduced the fluoride ion to 90 ppm with negligible U removal; anhydrous $CaSO_4$ in contact with a similar effluent reduced the Ca content from 0.6 to 0.042 g/l, also with negligible U removal. (L.M.T.)

12306

"ANORMAL" VALENCES OF RARE EARTH ELEMENTS IN PROCESSES OF THEIR SEPARATION. REPORT 1. ELECTROLYTIC REDUCTION OF YTTERBIUM. D. I. Ryabchikov, Yu. S. Sklyarenko, and N. S. Stroganova. Zhur. Neorg. Khim. 1, No. 9, 1954-67(1956). (Translated from Referat. Zhur. Khim. No. 8, 1957, Abstract No. 26431.)

The influence of various factors on the yield of Yb in the electrolytic reduction of a solution containing ytterbium acetate $Yb(Ac)_3$ and potassium citrate K_3Cit was studied using a Hg and a Pt anode. The dry citrate was added to the acetate solution, and the pH was adjusted by adding CH_3COOH or KOH. The electrolysis was carried out for one hour at 12 v and a cathode current density of 0.05 amp/cm^2, after which the amalgam was detached and dissolved with HCl. The maximum yield of Yb was at pH 6.0. The yield decreases gradually with a pH change to 4.0 and drops sharply at pH 3.0. The optimum cathode current density was 0.025 amp/cm^2. A temperature rise from –5 to 5° results in a small increase of the yield, but a further temperature rise to 50° decreases the yield by a factor of two. The mechanism for the formation of the amalgam is probably the dissociation of $Yb(Ac)_3$, formation of the complex $K_3[Yb(Cit)_2]$ and its dissociation, reduction of Yb^{3+} to Yb^{2+}, and reduction of Yb^{2+} to the amalgam. The conditions for the optimum yield of 98.2% Yb are pH 6, temperature 5°, a solution concentration of 2.0% Yb_2O_3, and a molar ratio of $Yb_2O_3 : K_3Cit :: 1 : 2$. (J.S.R.)

5151

CO-PRECIPITATION OF La^{140}, Pm^{147}, AND Y^{91} WITH TETRAVALENT CERIUM IODATES. V. P. Shvedov and Sh. A. Musaev. Radiokhimiya 1, 465-74(1959). (In Russian)

The carrier-free co-precipitation of La^{140}, Pm^{147}, and Y^{91} with tetravalent cerium iodate was investigated. Isotope purity was checked by La^{140} decay and by the maximum energy of Pm^{147} and Y^{91} β particles. The reagents were purified and solutions were prepared using twice-distilled water. Measurements were taken with a front window counter with a statistical order of error of 1 to 5% depending on the activity of the specimen. (R.V.J.)

RARE EARTHS - Other 2.39.04

7297 A/CONF.15/P/2217
RAZDELENIE ISOTOPOV REDKOZEMEL'NYKH ELEMENTOV ELEKTROMAGNITNYM METODOM. (Electromagnetic Separation of Isotopes of the Rare-Earth Elements.) B. A. Alekseev, S. F. Bulygin, et al. (U.S.S.R.). 16p.

The isotopes of the rare earth elements are separated in electromagnetic facilities to furnish suitable isotopes for various physical investigations and to supplement the isotope pool. The work is carried out with a large four-chamber facility and a small-size high-dispersion separator. The small unit uses ionic sources discharging in the vapors of a ballast or working substance. The source and receivers employed in the large unit are of the conventional type. The separation process is described, and data concerning the operating conditions of the sources, the productivities attained, and the isotope composition of the enriched products are given. Owing to the high cost of the initial substances, they have to be regenerated. For the same reason it has been found advisable to substitute the individual rare earth elements by their more available and cheaper concentrates, particularly those obtained by fractional crystallization. The use of concentrates makes it possible to apply fine chemical refining to the isotopes after enrichment, when their quantities are much smaller than those of the initial substances. It is often possible simultaneously to isolate isotopes of accompanying elements as enriched preparations. For instance, certain isotopes of samarium have been isolated simultaneously with those of neodymium and gadolinium during the separation of the latter. The preparation of working substances for the separation of rare earth isotopes is described, as well as the procedures for chemical treatment of the enriched products. (auth)

12370 CN-2823
[Clinton Labs., Oak Ridge, Tenn.]
THE COPRECIPITATION OF THE TRIVALENT RARE EARTHS WITH BISMUTH PHOSPHATE. Report for Period March 1 to May 15, 1945 on Problem Assignment CX3-5. Part II. L. S. Meyers, Jr. June 8, 1945. Decl. Apr. 4, 1957. 15p. Contract W-7405-eng-39. $3.30(ph OTS); $2.40(mf OTS).

Lanthanum, Ce, Pr, Eu, and Y were carried to nearly the same extent by α-$BiPO_4$ when precipitation was brought about by rapid addition of a 5N HNO_3 solution of $BiPO_4$ containing rare earth tracer to 0.025M H_3PO_4 at 75°C. The rare earth distribution, as shown by fractional dissolution of the precipitate, was nearly homogeneous, permitting calculation of the Berthelot-Nernst distribution constants. Values ranged from 0.001 to 0.0025. Lanthanum, Ce, and Pr were carried to essentially the same extent by β-$BiPO_4$ when the precipitation of the β form was carried out by a 70 hr digestion of an α-$BiPO_4$ precipitate with an initial homogeneous rare earth distribution. The distribution in the resulting precipitate was neither homogeneous nor logarithmic. Yttrium was carried to a lesser extent under these conditions, presumably because it forms a stable tetragonal phosphate which is not isomorphous with the stable monoclinic β-$BiPO_4$. Interpretation of fractional dissolving experiments involving α-$BiPO_4$ is complicated slightly by the partial conversion to β-$BiPO_4$. Since β-$BiPO_4$ dissolves much more slowly than α-$BiPO_4$, its presence leads to an apparent enrichment in the last fractions. (auth)

SEPARATION OF RARE EARTHS FROM BERYLLIUM, MAGNESIUM, ZIRCONIUM, TITANIUM, URANIUM, AND STAINLESS STEEL. M. W. Lerner and L. J. Pinto (U. S. Atomic Energy Commission, New Brunswick, N. J.). Anal. Chem. 31, 549-51(1959) Apr.

Certain rare earths possessing high thermal neutron absorption cross sections, when present in only trace quantities in metals used in nuclear technology, must be separated before a satisfactory spectrographic determination can be made. These rare earths are separated from beryllium and magnesium by precipitation as oxalates with added thorium as a carrier. The thorium is removed by an 8-quinolinol extraction leaving a residue suitable for spectrographic analysis. With zirconium, titanium, uranium, and stainless steel, a preliminary fluoride precipitation is made. At least 96% of the rare earths are consistently recovered.

REDUCTION 2.40

10870 CT-2433
Chicago. Univ. Metallurgical Project.
THE USE OF SULFIDE CRUCIBLES FOR REMELTING AND REDUCTIONS. L. Brewer, L. A. Bromley, N. Lofgren, P. Gillis, and W. Gwinn. Nov. 21, 1944. Decl. Feb. 19, 1957. 7p. $1.80(ph OTS); $1.80(mf OTS).

Th_4S_7, Th_2S_3, ThS, Ce_2S_3, Ce_3S_4, and CeS have been satisfactorily used for remelting of cerium metal in a vacuum at 1500°C. Results of tests are given and the effect of oxide impurities in the sulfide crucibles is considered. Cerium halide reductions have been carried out in CeS crucibles. If the CeS is not pure, the crucible is badly cracked. Pure CeS crucibles are satisfactory containers for the metal reduction reaction. (auth)

1809
REDUCTION OF METAL CHLORIDES. (to St. Joseph Lead Co. (U.S.A.)). British Patent 776,124. Nuclear Eng. 2, 452(1957) Oct.

Reduction of chlorides of titanium and zirconium using a steam of molten magnesium chloride in continuous circulation forming an upward and a downward current between an upper and a lower body of the chloride is reported. Molten magnesium and titanium tetrachloride or zirconium tetrachloride are introduced in certain proportions into the lower portion of the upwardly inclined current. From the lower body a suspension of titanium or zirconium in magnesium chloride is withdrawn. (auth)

RHODIUM 2.41

8371
THE SEPARATION OF RHODIUM AND IRIDIUM BY ION EXCHANGE. S. S. Berman and W. A. E. McBryde (Univ., of Toronto, Ont., Can.). Can. J. Chem. 36, 845-52(1958) May.

Separations of rhodium and iridium as chlorides by means of columns of the anion exchanger Amberlite IRA-400 are described. Iridium is maintained in the quadripositive state by the addition of cerium(IV), the presence of which is necessary to counteract the reducing action of the resin. The marked difference in affinity toward the resin of Ir(IV) and Rh(III) makes the separation possible. Rhodium can easily be eluted from the resin by 2M hydrochloric acid. Removal of all the iridium from the resin is accomplished in a Soxhlet extractor with 6M hydrochloric acid. A number of less successful procedures for this separation are discussed. (auth)

6589 AERE-C/R-1870
Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.
THE SEPARATION OF RHODIUM-105 FROM MIXED FISSION PRODUCTS. R. B. Chenley, R. G. Osmond, and S. G. Perry. Feb. 1956. 12p.

A method is described for isolating pure Rh^{105} from mixed fission products. The procedure involves a wet oxidation. and subsequent purification of the Rh^{105} by precipitation as potassium rhodionitrite in the presence of Sb and Te hold back carriers. Other methods of purification of Rh are examined. Two spectrophotometric methods are described for the determination of Rh in the 25 to 200 μg range using the 2-mercaptobenzoxazole and SnCl complexes respectively. The 2-mercaptobenzoxazole method is more sensitive than the SnCl procedure, but the latter gives extremely reproducible results and is to be preferred. (auth)

RUTHENIUM 2.42

See also, under WASTE TREATMENT AND DISPOSAL, FISSION PRODUCT REMOVAL--Ruthenium (8.05.04.03).

2493
SOLVENT EXTRACTION OF RUTHENIUM. H. H. Hyman and G. R. Leader (to U. S. Atomic Energy Commission). U. S. Patent 2,894,816. July 14, 1959.

The separation of ruthenium from aqueous solutions by solvent extraction is described. According to the invention, a nitrite selected from the group consisting of alkali nitrite and alkaline earth nitrite in an equimolecular quantity with regard to the quantity of ruthenium present is added to an aqueous solution containing ruthenium tetranitrate to form a ruthenium complex. Adding an organic solvent such as ethyl ether to the resulting mixture selectively extracts the ruthenium complex.

RUTHENIUM 2.42

11623 HW-45620
Hanford Atomic Products Operation, Richland, Wash.
RUTHENIUM BEHAVIOR IN NITRIC ACID DISTILLATION. A. S. Wilson. Sept. 1, 1956. ~~Decl. Mar. 16, 1957.~~ 18p. Contract W-31-109-Eng-52. $0.30(OTS).

The volatilization of Ru increases with increasing HNO_3 concentration and reaches a plateau at acid concentrations of about 8 to 10M. Only about 1 to 2% of the Ru, at the most, is volatilized. Mild reducing agents such as HNO_2, NO_2, and a 30% TBP-Soltrol 170 mixture, suppress the volatilization of Ru from HNO_3. In the absence of air Ru distills from HNO_3 as RuO_4. In the presence of air an unidentified Ru species appears in the distillate. (auth)

3664 CEA-tr-X69
ETUDE SUR LA SÉPARATION DES PRODUITS DE FISSION PAR LA MÉTHODE DE DISTILLATION (1 ER RAPPORT)-MÉTHODE DE DISTILLATION DU RUTHENIUM (1 ERE PARTIE). (Study on the Separation of Fission Products by the Distillation Method. I. Method for the Distillation of Ruthenium.) T. Kambara. Translated by S. S. Minn from Bunseki Kagaku 5, 222-4(1956). 12p.

As a method for the distillation after oxidation of carrier-free ruthenium from fission products, the use of potassium bichromate in a solution acidified with sulfuric acid was studied. The apparatus used is described. The results showed that the yield of ruthenium is a maximum for a sulfuric acid concentration of 44% in a total volume of 40 cm^3 and for a potassium bichromate quantity of approximately 1.0 g. A comparison of this method with the utilization of potassium permanganate shows that the yield is of the same order, but the final point of distillation was clearer using the bichromate and the distillation time was shorter, being only 2 to 3 min. Also the concentration of sulfuric ions in the distillate from the bichromate method was less. The temperature of distillation of carrier-free ruthenium was found to be in the vicinity of that of water. The ruthenium distills in the form of the tetraoxide. A second distillation on a sample which had reached the final distillation point resulted in the recovery of a considerable quantity of ruthenium. (tr-auth)

6516 AERE-C/R-2413
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE CHEMISTRY OF RUTHENIUM WITH REFERENCE TO THE PLUTONIUM SEPARATION PROCESS. PART IV THE SULPHIDE TREATMENT FOR RUTHENIUM IN THE URANIUM STREAM. G. L. Miles and F. S. Martin. 1958. Date of MS. Nov. 1950. Decl. Apr. 1957. 18p. $0.54 (BIS).

The effects of the different variables in the copper coprecipitation method for removing ruthenium from plant solutions are presented in graphical form and are discussed. Liter scale experiments with the copper sulfide method and also with graphite, charcoal and antimony sulfide columns are described. The mechanism of the ruthenium removal process is discussed. It is concluded that although the graphite column process described is more efficient than a series of butex cycles in decontaminating uranium solutions from ruthenium, the engineering problems that would be involved weigh heavily in favor of the latter process. (auth)

4183 K-570
Carbide and Carbon Chemicals Div. K-25 Plant, Oak Ridge, Tenn.
REMOVAL OF RUTHENIUM FROM WASTE. G. A. Eaton, J. J. Finley, H. G. Hunter, F. Mills, and R. W. Vogel. Feb. 22, 1950. Decl. Jan. 6, 1956. 18p. Contract W-7405-eng-26. $3.30(ph OTS); $2.40(mf OTS).

Several insoluble compounds have been investigated as scavengers for removing radioactive Ru from solution. None were adequate from the standpoint of decontamination. The removal of Ru from solution by distillation of the tetroxide is much more promising. Although optimum conditions for this operation have not been established, 85 to 99% removal of Ru was effected by using strong oxidants such as Cl_2, O_3, $KMnO_4$, and $NaBiO_3$. Chlorine was most effective in alkaline solution, ozone in the pH range of about 3 to 10, and permanganate and bismuthate at still lower pH values. The distillation of RuO_4 can be used as a method to separate Ru from other fission-product radioisotopes which exist in aged metal waste. (auth)

RUTHENIUM 2.42

ADSORPTION OF RUTHENIUM BY ION EXCHANGE RESINS. Charles A. Prohaska. June 1958. 16p. (DP-291)

After heating with thiourea, Ru in dilute solutions of $UO_2(NO_3)_2$ is highly adsorbed by carboxylic acid resin. Adsorption efficiencies of "Amberlite 1RC-50," "Duolite C-65," and "Permutit H-70" resins are discussed.

145 HW-51663

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

EFFECT OF SOME ORGANIC AMINES ON THE EXTRACTION BEHAVIOR OF RUTHENIUM. A. S. Wilson and H. D. Warren. July 22, 1957. 13p. Contract [W-31-109-Eng-52]. $3.30(ph OTS); $2.40(mf OTS).

In the product decontamination processes used at Hanford, a major portion of the Ru present as a fission product is removed either in the feed preparation cycle by oxidation to RuO_4 and subsequent volatilization, or in a co-decontamination cycle by solvent extraction. In each case, however, there is some Ru which escapes oxidation and extracts into the organic phase in the first column, along with U and Pu. This Ru is believed to be in the form of an aquo or nitrato derivative of nitrosylruthenium. The work presently reported is an investigation of a few of the many potential complexing agents which could possibly react with nitrosylruthenium to give coordination compounds that would not extract. (auth)

2817 AERE-C/R-2319

Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.

NITRATO NITROSYLRUTHENIUM COMPLEXES AND THEIR EXTRACTION FROM NITRIC ACID SYSTEMS BY TRIBUTYL PHOSPHATE. PART II. MINIATURE EXTRACTOR RUNS. G. J. Ashworth, P. G. M. Brown, J. M. Fletcher, and A. G. Wain. July 1957. 26p.

The fate of Ru, in runs in which these complexes were present in $UO_2(NO_3)_2-HNO_3$ feed solutions to a countercurrent TBP extraction system, has been determined. The behavior of this form of Ru is correlated with the properties of the complexes given. Factors which are important or largely irrelevant to Ru decontamination are assessed for these complexes. (auth)

REMOVAL OF FISSION PRODUCTS FROM FEEDS. Merle K. Harman. May 1, 1957. p.262-276 of SYMPOSIUM ON THE REPROCESSING OF IRRADIATED FUELS HELD AT BRUSSELS, BELGIUM, MAY 20-5, 1957. 1165p. (TID-7534(Bks. 1-3); HW-49544A)

In the aqueous processes for the separation of Pu from U and the decontamination of these products from fission products formed during irradiation in the nuclear reactors, only ten or twelve fission products are ordinarily of interest. Of these fission products, all but three have relatively simple chemistry which leads to easy, clean separations from the U and Pu. The major problem in nearly all solvent extraction decontamination processes is the achievement of adequate separation from Ru, Zr, and Nb. This report deals with the removal of the latter three elements.

9539

RECOVERY OF RUTHENIUM FROM AQUEOUS SOLUTIONS. H. R. Schmidt and R. L. Moore (to U. S. Atomic Energy Commission). U. S. Patent 2,792,412. May 14, 1957.

A method for the separation of Ru from solutions of irradiated U is given. The Ru present may be precipitated by the addition of a quantity of an organic sulfo-compound, and the precipitate so formed is stable to temperature and acidity change. Mentioned as suitable precipitating agents are mercaptans, thioethers and disulfides. (auth)

19848 CEA-tr-R-701

ETUDE DE L'EXTRACTION DU RUTHENIUM À PARTIR DE SOLUTIONS NITRIQUES PAR DES SOLVANTS ORGANIQUES. (Study of the Extraction of Ruthenium from Nitric Solutions with Organic Solvents.) V. D. Nikolskii (Nikolsky) and V. C. Schmidt. Translated into French by [?] Kotlarov and B. de Trezvinsky from Zhur. Neorg. Khim. 2, 2746-51(1957). 19p.

The extraction of ruthenium peroxide from the tetravalent ruthenium nitrate and of ruthenium nitrosonitrates in nitric solution was examined using diethyl ether, tributyl phosphate in hydrogenated kerosene, and kerosene as the solvent. The results showed that only the nitrosonitrates are extractable in significant quantities. RuO_4 is instable in the organic phase. The behavior of the ruthenium found in a nitrosonitrate solution is analogous to the behavior of the radioruthenium found in nitric solutions of irradiated uranium. (J.S.R.)

RUTHENIUM 2.42

19877

THE EXTRACTION OF RUTHENIUM NITROSONITRATE BY BUTYLPHOSPHINIC ESTERS. A. V. Nikolaev and N. M. Sinitsyn (Inst. of Inorganic Chemistry, Siberian Section of the Academy of Sciences, U.S.S.R.). Doklady Akad. Nauk S.S.S.R. 127, 117-19(1959) July 1. (In Russian)

The extraction behavior of ruthenium nitrosonitrate in the butyl and dibutyl esters of butylphosphinic acid was analyzed. (R.V.J.)

IMPROVEMENTS IN OR RELATING TO REMOVAL OF RUTHENIUM FROM SOLUTIONS OF METAL NITRATES IN ORGANIC SOLVENTS. Samuel Slater Grimley and Ivor Wells (to United Kingdom Atomic Energy Authority). British Patent 811,771. Apr. 15, 1959.

Ru can be removed from organic $UO_2(NO_3)_2$ solutions by an aqueous strip. An organic extract containing $UO_2(NO_3)_2$ is contacted with an aqueous solution 0.1 N in HNO_3, 0.005 M in $FeSO_3NH_2$, and 8 M in NH_4NO_3 at 60°C in a countercurrent extraction apparatus. The $UO_2(NO_3)_2$ may then be stripped from the organic phase in H_2O or HNO_3 solution. The Ru content of $UO_2(NO_3)_2$ separated this way is greatly reduced. (T.R.H.)

FISSION-PRODUCT RUTHENIUM VOLATILITY AT HIGH TEMPERATURES. K. L. Rohde, C. E. May, et al. (Phillips Petroleum Co., Idaho Falls, Idaho). Ind. Eng. Chem. 51, 68-70(1959) Jan.

When a nitrate salt or acid solution containing fission-product ruthenium is decomposed thermally above 100°C, the ruthenium is oxidized in a local reaction, i.e., within the liquid or on the surface of the solid being formed, and appears as a volatile material, probably the tetroxide. Appreciable concentrations of nitrite ion added to the aqueous feed did not inhibit this oxidation, and it has been concluded that it would be difficult in practice to balance large quantities of fluidizing air or other oxidizing atmospheres with aqueous reducing agents. When the atmosphere in which the decomposition took place was reducing with respect to ruthenium tetroxide, i.e., in the presence of nitric oxide, the volatile tetroxide was not formed or the oxidation reversed so close to the solid that the ruthenium essen-

16300 ORNL-2532

Oak Ridge National Lab., Tenn.

AN ELECTROLYTIC PROCEDURE FOR THE REMOVAL OF RUTHENIUM AND NITRATE FROM ALKALINE WASTE SOLUTIONS. A. F. Messing and I. R. Higgins. Sept. 19, 1958. 36p. Contract W-7405-eng-26. $1.00(OTS).

The flowsheet proposed by KAPL for the treatment of alkaline nitrate radiochemical processing waste has been modified to include an ion-exchange step for the decontamination of cesium, strontium, and other cationic fission products. In laboratory studies of the electrolysis steps in a nitrate reduction cell, synthetic alkaline waste, 0.55 to 4.83 M total electrolyte, was decontaminated from ruthenium by factors of >210. The nitrate of 3.0 M waste was reduced to ammonia with current efficiencies of 100%. Power consumption was 4.7 kwh/lb of nitrate reduced. Significant factors affecting the rate of ruthenium decontamination were temperature, cathode area, cathode current density, and electrolyte concentration. Those affecting nitrate reduction current efficiencies were the cathode current density, electrolyte concentration, and stirring rate. In an acid-base membrane cell, reusable nitric acid as well as sodium hydroxide was regenerated. However, such a cell is less economical to construct and operate than the nitrate reduction cell. At least 5 kwh of power is required to transfer 1 lb of nitrate from ORNL type waste. In addition, the greater complexity of the acid-base cell makes it less adaptable for remote control. (auth)

3447

SEPARATION OF PLUTONIUM AND URANIUM FROM FISSION PRODUCTS. J. K. Dawson and A. E. Truswell (to U. K. Atomic Energy Authority). British Patent 778,051. Nuclear Eng. 2, 494(1957) Nov.

Production of plutonium and recovery of uranium from neutron irradiated uranium by organic solvent extraction of the nitric acid solution of the irradiated uranium in a number of stages does not readily eliminate all fission products from the uranium and plutonium. Some products, particularly ruthenium, present difficult problems. A simple method of separating plutonium and/or uranium, especially from ruthenium and rhodium, consists in treating the metal or compound with a gaseous fluorinating agent (hydrogen fluoride; chlorine trifluoride; bromide trifluoride) in admixture with 2 to 10% of a gaseous oxidizing agent (air; oxygen). (auth)

RUTHENIUM 2.42

1593

IMPROVEMENTS IN OR RELATING TO A PROCESS FOR THE TREATMENT OF NUCLEAR FUEL. Geoffrey John Ashworth, Peter George Minchin Brown, John Molyneaux Fletcher, and Arthur Gregory Wain (to United Kingdom Atomic Energy Authority). British Patent 822,290. Oct. 21, 1959.

A modification of a breeder reactor fuel treatment process is offered which gives improved Ru decontamination. In one process the fuel is dissolved in HNO_3, the pH is then adjusted, and the solution is extracted with TBP. Ru present in nitrosyl from before extraction is converted to the nitro form by addition of HNO_2 according to the modification. The nitro form extracts less easily thereby resulting in better decontamination. (T.R.H.)

16546 IDO-14458

Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.

THE ADSORPTION OF RUTHENIUM FROM NITRIC ACID–AIR MIXTURES. D. A. Hanson, B. J. Newby, and K. L. Rohde. June 8, 1959. 70p. Contract AT(10-1)-205. $2.00(OTS).

The adsorption of ruthenium tetroxide on silica gel and other adsorbents from a vapor phase of air–nitric acid–water has been studied to provide design data for a ruthenium adsorber. This adsorber was designed for the off-gas stream of a fluidized bed calciner used to decompose aluminum nitrate fuel reprocessing raffinates but may have broader application. A process has been developed wherein silica gel is used at slightly above the vapor dew point temperature to remove ruthenium preferentially from the off-gas. Decontamination factors of about 1000 are experienced. After saturation of the gel, the ruthenium is removed by washing with a small volume of water and the gel is regenerated by heating in a stream of dry air. Capacities of about 10 g of ruthenium per cubic foot of adsorber have been obtained. This is about 2000 curies per cubic foot with one-year-cooled fission products. Four cycles have been run on the same batch of adsorbent with uniform ruthenium retentions after water washing of about 10 per cent of the total loading. (auth)

2495

SEPARATION OF RUTHENIUM FROM AQUEOUS SOLUTIONS. M. Beederman, S. Vogler, and H. H. Hyman (to U. S. Atomic Energy Commission). U. S. Patent 2,894,818. July 14, 1959.

The separation of ruthenium from a ruthenium containing aqueous solution is described. The separation is accomplished by adding sodium nitrite, silver nitrate and ozone to the ruthenium containing aqueous solution to form ruthenium tetroxide and then volatilizing off the ruthenium tetroxide.

IMPROVEMENTS IN OR RELATING TO THE RECOVERY OF RUTHENIUM. William Edmund Grummitt and William Horton Hardwick. British Patent 812,682. Apr. 29, 1959.

Solvent extraction recovery of Ru from HNO_3 solutions from which U has already been extracted is described. The pH is adjusted to 1 to 3 by NH_4OH, then a wash with $C_2H_2Cl_4$ removes organic solvent. The Ru is then oxidized to the octavalent state by $Ce(NO_3)_4 \cdot 2NH_4NO_3$. The Ru is then extracted into $C_2H_2Cl_4$, washed with $Ce(NO_3)_4 \cdot 2NH_4NO_3$ solution, and recovered in HCl solution. (T.R.H.)

12548

IMPROVEMENTS IN OR RELATING TO THE EXTRACTION OF METAL COMPOUNDS FROM AQUEOUS SOLUTIONS. John Molyneux Fletcher (to United Kingdom Atomic Energy Authority). British Patent 811,772. Apr. 15, 1959.

A pretreatment is given which reduces Ru nitroso compounds in HNO_3 solutions, thereby rendering the Ru less soluble in the organic phase during subsequent solvent extraction. Thus, a nitric acid solution containing U, Pu, Ru, and other fission products is treated with $FeSO_3NH_2$ plus N_2H_4 at 80°C for a period of time depending on the amount of Ru to be reduced. During solvent extraction with cyclohexanone or β, β'-dibutoxydiethyl ether the Ru remains largely in the aqueous phase. (T.R.H.)

RUTHENIUM 2.42

SEPARATION OF RUTHENIUM FROM URANIUM HEXAFLUORIDE. R. A. Gustison, S. S. Kirslis, T. S. McMillan, and H. A. Bernhardt. Apr. 26, 1950. Decl. Jan. 6, 1956. 33p. (K-586)

In the UAP process for recovery of U from Hanford waste, Ru^{106} is an undesirable radioactive contaminant in the phosphate precipitate. Ru forms a very reactive volatile fluoride which is carried along with the UF_6 when $UO_2NH_4PO_4$ is fluorinated. It was found that passing the UF_6 through a distillation column effectively reduces the Ru activity in UF_6 to an acceptable level. It was shown that the decontaminating effect of the distillation operation was due largely to the scrubbing of ascending gases by refluxing liquid UF_6. To a lesser extent, absorption of Ru on the column packing and the distillation action contributed to the decontamination.

3490 CNL-41
Clinton National Lab., Oak Ridge, Tenn.
THE BEHAVIOR OF RUTHENIUM UNDER SOLVENT EXTRACTION. G. R. B. Elliott and F. T. Miles. Feb. 27, 1948. Decl. Dec. 20, 1955. 30p. Contract W-35-058-eng-71). $4.80(ph OTS); $2.70(mf OTS).

Studies were carried out to help understand the two-phase distribution behavior of ruthenium. Distribution data are presented. It was found that the distribution behavior could be explained by four forms of ruthenium and various equilibrium constants and reaction rates. Estimates of these values are given and a possible assignment of states is suggested. (auth)

THOREX SHORT COOLED PROCESSING. Presented at Nuclear Engineering and Science Conference, held at Chicago, March 17 to 21, 1958. Preprint 122, Session 37. A. B. Meservey and R. H. Rainey (Oak Ridge Nat. Lab., Tenn.) New York, American Institute of Chemical Engineers, 1958. 7p.

The conventional Thorex flowsheet for the aqueous processing of long-decayed neutron-irradiated thorium slugs gives poor decontamination from iodine and ruthenium when short-decayed slugs are processed. Good decontamination is obtained after a head-end treatment with potassium iodide and the addition of sodium bisulfite to the the feed. (auth)

SILICON 2.43

13041 DP-293
Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Augusta, Ga.
REMOVAL OF SILICA FROM SOLUTIONS OF NUCLEAR FUELS. Harold J. Groh. June 1958. 12p. Contract AT(07-2)-1. $0.50(OTS).

By the addition of gelatin, small amounts of silica present in nitric acid solutions of metals can be flocculated for ready removal by filtration or centrifugation. In the processing of nuclear reactor fuels by solvent extraction, the prior removal of silica by gelatin reduces emulsification and solids accumulation without complicating product recovery, fission product removal, or waste disposal. (auth)

557 WAPD-CTA(GLA)-156(Rev. 1)
Westinghouse Electric Corp. Bettis Plant, Pitts[illegible]gh.
THE DETERMINATION OF SILICON AS AN IMPURITY IN ZIRCONIUM AND ZIRCALOY. G. W. Goward, B. B. Wilson, and S. Kallman. Apr. 29, 1957. 5p. $1.80 (ph OTS); $1.80(mf OTS).

Hydrofluoric acid is used both to dissolve the sample and convert the silicon to a reactive form. The silicon is reacted with molybdic acid to form molybdisilicic acid, which is then reduced to a heteropoly blue complex. Photometric measurement is made at 815 mu. The method covers the determination of silicon as an impurity in zirconium and Zircaloy in the range of 10 to 200 ppm on a one gram sample basis. (auth)

7986
ELECTROLYSIS OF $CaO-Al_2O_3-SiO_2$ MELTS. O. A. Esin and V. A. Chechulin. (Kirov Ural Polytechnic Inst.). Doklady Akad. Nauk S.S.S.R. 113, 109-11(1957) Mar. 1. (In Russian)

Tables for $CaO-Al_2O_3-SiO_2$ melt electrolysis (for cathode cells h/d = 7.5 to 8.0) in the temperature interval from 1385 to 1440°C revealed Si as the basic cathode product with the yield varying with the current from 38 to 71% and the Al yield about 24%. The total power utilization was from 42 to 90%. Analysis was made to determine the processes which consume the balance of the electrical power. Data on anode dissolving of Si from Fe-Si (21.3% Si) and Cu-Si(17.5% Si) in various slags are also included. (R.V.J.)

SOLVENT EXTRACTION 2.44

See also, under PROCESS CHEMISTRY AND ENGINEERING,

SOLVENT EXTRACTION (6.16).

15077

SEPARATION OF FISSION PRODUCTS BY LIQUID–LIQUID EXTRACTION WITH CUPFERRON–CHLOROFORM. Toshiyasu Kiba and Mitsue Kanetani (Kanazawa Univ., Japan). Bull. Chem. Soc. Japan 31, 1013-16(1958) Dec.

To separate the radioactive strontium and cesium from solutions containing gross fission products and other non-radioactive metallic ions, cupferron–chloroform extraction was performed. By changing the acidity of the aqueous solution from 1 n hydrochloric acid to pH 4, and by performing extractions in each stage, the strontium and the cesium remained in the aqueous phase, while the other was removed into the organic phase. The radioactive strontium may be extracted in the organic phase by the following extraction with TTA–hexone at pH 8.

1299

PREPARATION OF RADIOCHEMICALLY PURE CERIUM BY SOLVENT EXTRACTION. H. W. Kirby (Mound Lab., Miamisburg, Ohio). Anal. Chem. 29, 1599-1601(1957) Nov.

Radiochemically pure Ce can be prepared rapidly and inexpensively from reagent grade cerous nitrate by liquid-liquid extraction with tri-n-butyl phosphate. Ce and Th are extracted into TBP. Ce is stripped from organic phase with 8N HNO_3. Product contains 80% of Ce and less than 2% of original radioactivity. (auth)

199

METHODS OF ISOLATION OF CARRIER-FREE RADIOACTIVE ISOTOPES. PRODUCTION OF RADIOCHEMICALLY PURE ThB AND ThC. N. P. Rudenko (Second Research Inst. of Physics, Moscow State Univ.). Zhur. Anal. Khim. 11, 371-5(1956) July–Aug. (In Russian)

A rapid and simple extraction method for separation of radioisotopes ThB(Pb^{212}) and ThC(Bi^{212}) has been developed Radiochemically pure preparations of Pb and Bi radioisotopes, both carrier free and with carrier, were obtained by the newly developed method. (tr-auth)

181 BM-RI-5239

Bureau of Mines.

SEPARATION OF TANTALUM–COLUMBIUM BY SOLVENT EXTRACTION. K. B. Higbie and J. R. Werning. Dec. 1955. 53p.

The quantitative separation of Ta from Nb has been obtained through several liquid-liquid extraction processes. Both Ta and Nb products of greater than 99% purity were obtained when HF–HCl solution of mixed hydrated oxides was contacted with methyl isobutyl ketone. (W.L.H.)

6358 A/CONF.15/P/1280

A SOLVENT EXTRACTION METHOD FOR Co^{2+}. Silvia Ionescu and Carmen Grigorescu-Sabău (Inst. de Physique Atómique, Bucharest). 8p.

A comparative investigation of the extraction of Co^{2+} and Co^{3+} ions in the presence of each other in neutral solution is reported. A more efficient separation method of these ions is proposed, the extraction of Co^{2+} ions as $(Co^{2+}Py_4)(SCN)_2$ with $CHCl_3$. The method can be used also with tracer quantities. The formation of the complex was investigated by this solvent extraction method varying each of the components in quantity the other being in excess. In this way it was observed that the radiometric titration. with $SCNNH_4$ can be applied successfully to the quantitative determination of Co^{2+}. The equilibrium shift obtained at the titration with pyridine allowed the calculation of the chemical potential for the combination of cobalt with pyridine. (auth)

SOURCE PREPARATION - General 2.45.01

16358

SURVEY OF GAMMA FACILITIES IN U. S. AND CANADA—AN UPDATING. Nucleonics 17, No. 7, 88(1959) July.

Nucleonics recently made a survey of industrial gamma facilities in the U. S. and Canada. A tabulation of gamma facility characteristics brought up to date by a recent questionnaire is given. (A.C.)

SOURCE PREPARATION - General 2.45.01

6377 NAVORD-3948
Naval Ordnance Lab., White Oak, Md.
VACUUM EVAPORATION OF HEAVY METALLIC FILMS.
W. R. Turner. June 2, 1955. 33p.

The development and operation of vacuum evaporation equipment capable of forming metallic films 10 to 40 times the thickness obtained in commercial practice are described. On the basis of the equation defining the rate of metal transfer to the surface being coated, the primary requirement for the evaporation of a heavy film is a source of comparatively large area. Such a source was devised in the form of a flat tantalum dish heated by electronic bombardment. Important aspects of the development include the design of a water-cooled fixture to hold the evaporation dish, an electronic circuit breaker to control the bombardment power supply, and an electrical thickness gage to record the film thickness as it is evaporated. Although only a limited number of metals have been evaporated, the method is believed to be applicable to a wide range of metals, alloys, and non-metals. (auth)

ELECTRODEPOSITION OF THE ACTINIDE ELEMENTS.
Ko, R. (Hanford Atomic Products Operation). Nucleonics 15, 1, pp. 72-7, 1957.

Paper is concerned with the preparation of thin films by electrodeposition methods. A general review of the subject is made and experimental techniques are described for thorium, uranium, neptunium, plutonium, americium, and curium.

THE DESIGN AND THE CONSTRUCTION OF A 10,000 CURIE COBALT-60 GAMMA RADIATION FACILITY.
A. Danno, M. Omura, H. Hotta, H. Hirakawa, G. Tsuchihasi, and I. Yamaguchi (Japan Atomic Energy Research Inst., Tokyo). p.349-60 in "Proceedings of the Seventh Hot Laboratories and Equipment Conference."

A high gamma radiation facility with 10,000 curie cobalt-60 source has been in operation at the Japan Atomic Energy Research Institute for a year. The design of the irradiation cave and the construction of the source cylinder are described. The experimental results associated to this work are also given. (auth)

9205
EQUIPMENT FOR ELECTRON IRRADIATIONS. Richard M. Lemmon and Duane F. Mosier (Univ. of California, Berkeley). Radiation Research 4, 373-7(1956) May.

Equipment is described which was used for the electron irradiation of 50- to 100-mg samples of organic compounds contained in glass tubes under high vacuum. The entire electron beam was allowed to pass through the sample and to impinge on an electron collector mounted behind the sample holder. The sample holder and the electron collector were mounted in a high vacuum so as to avoid air scattering of the electron beam and air ionization. The experimental set-up is described which permits fairly accurate estimates of the energies imported by the electron beam to the samples. (C.H.)

101
PRODUCING FILMS OF URANIUM OXIDE. (to U. K. Atomic Energy Authority (U.S.A.)). British Patent 786,733. Nuclear Eng. 3, 272(1958) June.

The relative proportions of different isotopes present in a radioactive element may be determined by measuring the intensity of the radiation given off by the element, e.g., by counting the number of alpha particles emitted from a given weight of the material in a unit length of time and comparing this count with a standard sample. It has been found that the desired accuracy can be obtained by forming on a metal support (disc) an adherent film of a compound of the radioactive element (oxide of the element). A film of uranium oxide is produced on a polished metal surface (gold or a metal of the platinum-palladium group) by spraying on that surface, in atomized form, a solution of a uranium salt (uranyl chloride) in an organic solvent (amyl acetate) containing a binder. The coating is heated to convert the salt to U_3O_8.

SOURCE PREPARATION - General 2.45.01

21395
PORTABLE SOURCE OF RADIOACTIVITY. Raymond C. Goertz, Kenneth R. Ferguson, Elmer William Rylander, Lenard M. Safranski (to U. S. Atomic Energy Commission). U. S. Patent 2,891,168. June 16, 1959.
A portable source for radiography or radiotherapy is described. It consists of a Tl^{170} or Co^{60} source mounted in a rotatable tungsten alloy plug. The plug rotates within a brass body to positions of safety or exposure. Provision is made for reloading and carrying the device safely. (T.R.H.)

14467
RADIOACTIVE SOURCES. W. Harrison Faulkner, Jr. (Tracerlab, Inc., Waltham, Mass.). Electronics 32, No. 21, 57(1959) May 22.
The characteristics of radioactive materials available for use in noncontacting thickness gages are tabulated. (T.R.H.)

A POWERFUL RADIATION SOURCE FOR LABORATORIES. C. G. Invernizzi (U. S. Radium Corp., Geneva). Inds. atomiques 2, No. 9-10, 153-4(1958). (In French)
A brief description is given of the design and characteristics of the "Gammacell-220," a 59,000-c gamma source. (J.S.R.)

11543
PORTABLE X-RAY OR GAMMA SOURCE. S. Untermyer (to U. S. Atomic Energy Commission). U. S. Patent 2,798,164. July 2, 1957.
A source of radioactivity is described which is compact and portable. The assembly comprises a body of shielding material having a curved passage extending therethrough, a capsule containing radioactive material and being slidably mounted in the passage for movement between an active position adjacent a wide end passage opening and an inactive position midway between the passage ends, and a wire rod attached to the capsule in cooperation with a spring to enable an operator to move the capsule into the active position and automatically return the capsule to the inactive position when radiation is not desired. (auth)

2513
THE CONSTRUCTION OF RADIOISOTOPE CARRIERS FOR GAMMAGRAPHIC PURPOSES. R. A. Jonkers. Atoomenergie 1, 167-70(1959) Oct. (In Dutch)
The principles of gammagraphy and the required characteristics of radiation sources used are briefly described. The construction of various types of holders and carriers of radiation sources is then discussed. (tr-auth)

10151
RADIOACTIVE UNIFORM EXTENDED SOURCES. G. W. C. Tait and R. E. Townshend (Atomic Energy of Canada Ltd., Chalk River, Ontario). Rev. Sci. Instr. 28, 542-3(1957) July.
A device is described for producing a uniform distribution of a solution of radioactive material over a large area source. Droplets of controlled size are expressed from a syringe at a constant rate and systematically and uniformly placed over an area up to 50 cm square. (auth)

8511 TID-7554(p.306-17)
Little (Arthur D.) Inc., Cambridge, Mass.
RADIATION SOURCES AND FACILITIES. R. P. Epple. p.306-17 [of] PROCEEDINGS OF THE INTER-AMERICAN SYMPOSIUM ON THE PEACEFUL APPLICATION OF NUCLEAR ENERGY, BROOKHAVEN NATIONAL LABORATORY, MAY 13-17, 1957. 12p.
Various sources of radiation are described which have proved to be most useful and reliable. Technical and economic factors which affect the choice of a radiation source for a research laboratory or a production facility are reviewed. (C.H.)

SELECTED LIST OF NEUTRON AND GAMMA IRRADIATION FACILITIES IN OPERATION, BEING BUILT, OR PLANNED. Compiled by John H. Martens and F. G. Minuth. Argonne National Laboratory. (U. S. Atomic Energy Commission. TID-7009) (Nuclear Technology Series) Washington, Government Printing Office; 1957. 79 p. $0.60.
Forty facilities, currently operative or scheduled to become operative are described. Twenty-six of these are nuclear reactors suitable for irradiation use; the other fourteen are gamma ray facilities equipped with sources of three kilocuries or more. The book also contains technical data on each facility, information on the services provided and how to obtain them.

SOURCE PREPARATION- Binders 2.45.02

20939

KRYPTON IN A CAGE–CLATHRATE BETA SOURCES. D. J. Chleck and C. A. Ziegler (Tracerlab, Inc., Waltham, Mass.). Nucleonics 17, No. 9, 130-3(1959) Sept.

A new way of handling Kr^{85} consists of trapping the krypton in hydroquinone molecules to form a three-dimensional organic crystalline "cage" called a "clathrate." The cage is formed by crystallization from a melt under pressure, resulting in a stable source of beta particles. For use as a beta source the clathrate can be powdered into grains the size of salt or sugar. Safety in using the material results from its solubility. In the event of spill, water or ketones can be added to dissolve the organic crystal, thus permitting the inert krypton to escape harmlessly into the atmosphere. Applications of the clathrate are discussed. (C.J.G.)

THE PREPARATION OF VERY THIN ELECTRIC-CONDUCTING FOILS FOR ABSOLUTE β COUNTING. E. Huster and W. Rausch (Univ. of Marburg, Ger.). Nuclear Instr. 3, 213-17(1958) Oct. (In German)

Absolute β-counting with radioelements of low decay-energy is difficult because of absorption losses in the source and its backing. If moreover the half-life is very high, extended sources are necessary. It has been furthermore shown, that backings must be electrically conducting to prevent charging of the source and thereby distortion of the electric field of the counter, if counting is done with the source in the interior of the counter. A method is described for preparing electrically conducting formvar foils of 85 × 30 mm^2 with an over-all thickness of 10 $\mu g/cm^2$. The conductivity is attained by first exposing the foil to a glow discharge in a hydrocarbon atmosphere and then evaporating silver on it. (auth)

13585

A METHOD OF PREPARING STABLE ALPHA-, BETA-, AND GAMMA-SOURCES USING INORGANIC ENAMELS. D. M. Ziv, G. S. Sinitsyna, I. A. Efros, and E. A. Volkova. Atomnaya Energ. 4, 469-70(1958) May. (In Russian)

A method is offered for preparing α, β, and γ sources with an enamel base binding and shielding material. Stable α, β, and γ sources were prepared from radium salts with gold backing. The enamel composition was 30% BaO, 3% B_2O_3, 30% PbO, 34% SiO_2, 3% Na_2O. (R.V.J.)

'607 A/CONF.15/P/664

os Alamos Scientific Lab., N. Mex.

PREPARATION OF FOILS. J. G. Povelites. 12p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

The details of apparatus and techniques used for the preparation of foils from a wide variety of materials are presented. The average foil thickness is determined by weighing, counting, fission weighing, or by calorimetric analysis. Uniformity is determined by counting or weighing small areas or by exposure to a nuclear emulsion. Impurities are determined by chemical analyses. The principal methods of preparation are electrodeposition, painting from solution, vacuum deposition, electrostatic spraying, and electrophoresis. Electrodeposition is used for the preparation of films of a few $\mu g/cm^2$; uniformity and deposition efficiency

7801 AECU-3618

Michigan. Univ., Ann Arbor. Engineering Research Inst.

PREPARATION OF RADIATION SOURCES FROM FISSION PRODUCTS BY THE CLAY PROCESS. J. E. Schoolmeester and J. J. Martin. Aug. 1957. 16p. Contract AT(11-1)-162. (ERI-1943-4-106-P). $0.75(OTS).

This study was made to determine the feasibility of producing usable radiation sources by the montmorillonite clay process. The clay process was developed at Brookhaven National Laboratory primarily to solve the problem of ultimately disposing of waste fission products. After reviewing the process in detail, it is shown that radiation sources may be prepared with specific activity as high as 4.5 curies of Ce^{137} per gram of clay. Sources of this strength would be entirely suitable for such processing applications as promotion of chemical reactions, preservation of foods, or sterilization of drugs. Furthermore, the operations involved in the clay process are simpler and

RADIONUCLIDES IN FUSED ENAMEL MAKE STABLE RADIATION SOURCES. Clifton Blincoe (Univ. of Missouri, Columbia). Nucleonics 14, No. 8, 82-3(1956) Aug.

A technique is presented for making stable sources of radionuclides (for example Sr^{90}). The radionuclides are mounted as components of a fused enamel in a manner similar to that used for applying decorative enamels to small jewelry. (W. L. H.)

SOURCE PREPARATION - Binders 2.45.02

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NEW PREPARATION METHODS OF α-, β-, AND γ-SOURCES. Presented at the International Conference on Radioisotopes in Scientific Research, Sept. 9-20, 1957 at Paris. No. UNESCO/NS/RIC/11. M. S. Petrova, D. M. Zeav, Shwebelbleet, I. I. Balaklayets, W. P. Sytin, and W. N. Tshessalin. London, Pergamon Press, Ltd., 1957. 9p.

The advisability of the practically universal methods of preparing α-, β-, and γ-sources on the basis of oxide films and on the basis of inorganic enamels is shown, such sources allowing for a wide range both in intensity and in form. (auth)

ON SOME PROBLEMS OF TECHNIQUES IN RADIOCHEMICAL EXPERIMENTS. A. A. Goryunov (Novocherkassk Hydrochemical Inst.). Zhur. Analit. Khim. 11, 590-9(1956) Sept.-Oct. (In Russian)

A number of improved auxiliary devices are offered for use in radiochemical experiments. Descriptions include an improved protective housing for the end-window counter; a vertical casing for the aluminum absorbers; celluloid plates; pressforms and a heater for celluloid plate molding; and, an evaporator for drying radioactive samples. (R.V.J.)

SOURCE PREPARATION - Calibration 2.45.03

11750

PRESENT STATUS OF NEUTRON SOURCE CALIBRATIONS. Karl-Erik Larsson (AB Atomenergi, Stockholm). J. Nuclear Energy 6, 322-30(1958) May.

During the last three years, six different Ra–Be neutron sources have been compared directly to the Swedish standard Ra–α–Be source, these six sources coming from U.S.A., U.S.S.R., U.K., Switzerland, and Belgium. On the basis of this series of direct intercomparisons, a "world" average is defined and it is shown that all the absolute measurements fall within ± 2.4 per cent of this average. A survey is given of the absolute measurements included in this direct intercomparison series. (auth)

SOURCE PREPARATION - Calibration 2.45.03

11260 AERE-R/R-2097

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

CALIBRATION OF SPONTANEOUS FISSION NEUTRON SOURCES. R. Richmond and B. J. Gardner. Mar. 1957. 21p. (TNCC(UK)-12).

A spontaneous fission neutron source consisting of a one-inch diameter sphere of plutonium containing $8\frac{1}{2}$% Pu-240 was calibrated by comparison with a number of standard neutron sources in a tank of manganous sulfate solution. The value obtained for the strength of the source was $2.032 \pm 0.030 \times 10^4$ neutrons/sec. The source was used to determine the strengths of similar sources from Chalk River and Los Alamos and also to measure the spontaneous fission neutron emission rate of natural uranium. (auth)

6681 CRDC-687

Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.

AN IMPROVED FILTRATION SYSTEM FOR ASSAY OF RADIOACTIVE PRECIPITATES. R. E. Jervis. Jan. 1957. 10p. (AECL-428). $0.20(OTS).

Millipore molecular filter discs have been applied to the gravimetric assay of radioactive precipitates deposited by a filtration technique. Filter discs of this material are superior to filter paper discs for source preparation, and can result in a fivefold improvement in the precision of semi-micro analysis of source deposits. A readily assembled Teflon filtration apparatus for supporting the Millipore filter discs is described. (auth)

11321 AECU-3446

Argonne Cancer Research Hospital, Chicago.

DOSIMETRY OF KILOCURIE Co^{60} SOURCES. Lawrence T. Zimmer. Oct. 1956. 21p. Contract [AT(11-1)-222]. $4.80(ph OTS); $2.70(mf OTS).

In an effort to determine the γ-ray intensity from several Co^{60} sources, some primary and secondary dosimeters were constructed. Methods of calorimetry, ferrous sulfate oxidation, ionization chambers, and photographic film were studied and radiation intensity evaluated. Results from the absolute determinations were compared with those from a Victoreen condenser type meter calibrated by the National Bureau of Standards for Co^{60}, and the ionic yield of ferrous sulfate measured. Data are tabulated. (auth)

SOURCE PREPARATION - Calibration 2.45.03

COMPLETELY AUTOMATIC MECHANIZED MULTI-KILOCURIE COBALT-60 IRRADIATION FACILITY FOR SCIENTIFIC RESEARCH, LARGE-SCALE INDUSTRIAL APPLICATION, AND RADIATION THERAPY. O. F. Joklik (Transcontinental Atomic Co., Lugano, Switzerland). Atompraxis 4, 355-63(1958) Oct. (In German)

The large-scale industrial use of gamma radiation requires highly versatile research facilities with multi-kilocurie Co^{60} radiation sources. Certain constructive examples of completely automatic mechanized gamma-radiation facilities are given, in which the radiation source can either be immersed or the objects under exposure can be radiated in any desired physical form, in charges or continuously, beside the vertical rod-shaped radiation source in one or more parallel radiation cylinders; the radiation can be switched off automatically either after a predetermined time (up to 120 hours) or after a certain dose (up to 10 million r), and radiation conditions can be varied at will from +450° to

13196

COBALT RADIATION SOURCES. W. E. Parker (Budd Co., Philadelphia). Atomics and Nuclear Energy 9, 234-5(1958) July.

The facilities of the Budd Co., Philadelphia, for preparing, handling, canning, and applying Co^{60} gamma sources are depicted and described. (T.R.H.)

108

SOME METHODS OF MASS PREPARING Po-α-Be NEUTRON SOURCES. G. S. Komaishko, V. I. Matvienko, et al. Atomnaya Energ. 5, 64-7(1958). (In Russian)

A wet method of preparing Po-α-Be sources based on a polonium and beryllium mixture prepared by conducting the polonium nitrate solution through a beryllium powder and drying and pulverizing the resulting mixture is described. The method of preparing copper-free polonium nitrate is also described. The wet method is not suitable for mass production of sources due to strong neutron activity in the basic technological process. A dry method is proposed for mass production in which copper powder, with a known quantity of Po^{210}, is weighed out into containers which are then filled with beryllium powder. The hermetically tight containers are then heated, sublimating Po^{210} and distributing it evenly in the mixture. (tr-auth)

14443

RADIATION SOURCES. M. H. Brucer (to U. S. Atomic Energy Commission). U. S. Patent 2,831,122. Apr. 15, 1958.

A novel long-lived source of gamma radiation especially suitable for calibration purposes is described. The source of gamma radiation is denoted mock iodine-131, which comprises a mixture of barium-133 and cesium-137. The barium and cesium are present in a barium-cesium ratio of approximately 5.7/1 to 14/1, uniformly dispersed in an ion exchange resin and a filter surrounding the resin comprised of a material of atomic number below approximately 51, and substantially 0.7 to 0.9 millimeter thick.

14540 A/CONF.15/P/822

Brookhaven National Lab., Upton, N. Y.

EUROPIUM-155 AS A SOURCE IN PORTABLE RADIOGRAPHIC DEVICES. James S. Robertson. 9p. $0.50 (OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

The problem of obtaining radiographs suitable for diagnostic interpretations in locations remote from adequate power supplies leads one to look to the gamma-emitting radioisotopes as possible substitutes for x-ray machines. Energetic gamma emitters such as cobalt-60 have been used successfully in industrial radiography. In order to achieve the necessary contrast, however, in radiographic work with human beings, gamma rays of much lower energy are required. Europium-155 offers the following advantages: a half-life of 1.7 years; 100% of the disintegrations yield 85 or 99 kilovolt gamma rays; the β^- energy is only 0.25 Mev, and at least in principle it can be produced carrier-free Europium-155 is produced from samarium-154 by the (n, γ-β) reaction. The production of europium-155 is

6704

THE FABRICATION OF ONE KILOCURIE SOURCES OF Cs^{137}. B. F. Warner (U.K.A.E.A., Windscale, Eng.). Énergie nucléaire 1, 161-71(1957) July-Sept. (In French)

Because of the increasing demand for radiocesium, a process was perfected and a pilot plant constructed for the extraction of several thousand curies of Cs^{137} from solutions of fission products from nuclear installations. The pilot process and the apparatus used in the installations of the United Kingdom Atomic Energy Authority at Windscale are described. The practical results of the operation are discussed. (tr-auth)

SOURCE PREPARATION - Calibration 2.45.03

3212 ORNL-2050
Oak Ridge National Lab., Tenn.
GEOMETRICAL CORRECTIONS FOR ANISOTROPICALLY EMITTING SOURCES. M. E. Rose. Mar. 19, 1956. 12p. Contract W-7405-eng-26.

Alpha particle angular distribution studies led to an investigation of necessary geometrical considerations. Assuming coaxial circular source and detector, uniform emission, detector efficiency, and good geometry, a method of determining geometrical corrections is developed. (D.E.B.)

6571
RADIOACTIVE STANDARDS PREPARATIONS. C. F. Weiss. Berlin, Veb Deutscher Verlag der Wissenschaften. 1956. 232p. (In German)

2375 AECD-3801
Knolls Atomic Power Lab., Schenectady, N. Y.
DENITRATION LOSS OF RUTHENIUM FROM URANYL NITRATE BETA MOUNTS. H. A. Mahlman and C. W. Decker. Jan. 25, 1952. Decl. with deletions Dec. 5, 1955. 8p. Contract W-31-109-Eng-52. $1.80(ph OTS); $1.80(mf OTS).

During the preparation of beta-gamma mounts of uranyl nitrate it is possible to effect a denitration loss of approximately 80% of the Ru. By adding hydroxylamine sulfate and sulfuric acid, the Ru is stabilized and the denitration loss is eliminated. The standard determination of Ru by calculation, utilizing a differential counting technique, has been found to be approximately the same as the standard denitration of radiochemical assays. (C.H.)

FABRICATION OF NEUTRON SOURCES. J. H. Birden (to U. S. Atomic Energy Commission). U. S. Patent 2,870,339. Jan. 20, 1959.

A method is presented for preparing a more efficient neutron source comprising inserting in a container a quantity of Po-210, inserting B powder coated with either Ag, Pt, or Ni. The container is sealed and then slowly heated to about 450°C to volatilize the Po and effect combination of the coated powder with the Po. The neutron flux emitted by the unit is monitored and the heating step is terminated when the flux reaches a maximum or selected level.

CONTRIBUTION TO THE STUDY OF THE PREPARATION OF CESIUM SOURCES. J. Trocker, C. Fisher, and A. Raggenbass (Commissariat à l'Energie Atomique, Paris). Intern. J. Appl. Radiation and Isotopes 4, 96-107(1958) Dec. (In French)

The manufacture of strong Cs^{137} sources is an operation which poses many problems. These include the choice of salt with regard to its good specific activity and its stability under radiation, and the preparation of this salt in suitable form, either by fusion or by pelleting. An investigation was made of volatilization when fusion is used as a means of preparing sources of the two most interesting salts, cesium chloride and cesium sulfate. Cesium sulfate was found to be more volatile than the chloride. Nevertheless, taking into consideration the volatilization of the two salts and the possibility of obtaining a higher density and thus specific activity by compression of the salts, the advantage of choosing

PRODUCTION OF Co^{60} SURFACE SOURCES BY ELECTROLYSIS OF COBALT SOLUTIONS CONTAINING NITRATE. Rudolf Münze and Günther Reinhard (Zentralinstitut für Kernphysik, Dresden). Chem. Tech. (Berlin) 10, 662(1958) Nov. (In German)

A method for the direct precipitation of Co^{60} sources from dilute cobalt nitrate solutions is given. The cobalt is deposited on the cathode in a thin black layer. The conditions used in the electrolysis are described.

SOURCE PREPARATION - Isotopes 2.45.04

1608
Pm^{147} POINT SOURCE. John E. Gates and David F. Edwards (Battelle Memorial Institute, Columbus, Ohio). Nucleonics 13, No. 12, 57(1955) Dec.

A point source of Pm^{147} was prepared by electroplating onto the tip of a small diameter wire. The method appears to give satisfactory results. (B.J.H.)

1607
SECONDARY-STANDARD Co^{60} SOURCES PREPARED BY ELECTRODEPOSITION. Paul A. Caldwell and J. D. Graves (Naval Research Lab., Washington, D. C.). Nucleonics 13, No. 12, 49-51(1955) Dec.

The standard sources were prepared by deposition of Co^{60} on a platinum-iridium disk within a rotating-anode electrolytic cell. The Co is then sandwiched between another disk, and the disks are then brazed together around the edges. It is concluded that this method produces satisfactory sources. (B.J.H.)

A 90-CURIE Co^{60} IRRADIATION UNIT. A. L. Riegert and J. W. T. Spinks (Univ. of Saskatchewan, Saskatoon, Can.). p.315-24 in "Proceedings of the Seventh Hot Laboratories and Equipment Conference."

A simple 90-curie Co^{60} irradiation unit has been developed. The Co^{60}, contained in a lead drawer in a cylindrical lead housing, can be pushed out of the lead housing onto a track, thereby irradiating materials placed on either side of the track. Dose rates of up to 1500 r/min can be obtained. The source-house and track assembly is located in a concrete cave built with precast concrete blocks. The design provides for adequate radiation shielding and for interlocks on the source-moving mechanism and gate leading to the irradiation chamber. The unit is cheap and easy to construct and is adaptable to a wide range of radiation problems. (auth)

4606 AERE-M/M-80
Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.
MANUFACTURE OF A PLUTONIUM-BERYLLIUM NEUTRON SOURCE. J. Sheldon and J. Williams. Aug. 19, 1954. Decl. Dec. 20, 1956. 3p.

The preparation of a $PuBe_{13}$ neutron source by powder techniques is described. Incomplete homogenization is believed to be responsible for the flux being lower than anticipated at $\sim 10^5$ neutrons/sec. (auth)

2747 WSL-R-39
United Kingdom Atomic Energy Authority. Industrial Group. Windscale Works, Sellafield, Cumb., England.
PREPARATION OF THIN UNIFORM FILMS OF PuO_2 SUITABLE FOR FISSION FRAGMENT COUNTING. J. Shaw, A. Whittaker, L. Polley, and G. Wortley. 1958. Date of MS. Aug. 12, 1952. 7p.

Thin films of PuO_2, suitable for determination of Pu^{240} by counting the number of spontaneous fissions, can be prepared by dropping a plutonium solution on to the center of a spinning disk and igniting the salt to oxide. (auth)

3378 TID-5087
Mound Lab., Miamisburg, Ohio.
PREPARATION, PROPERTIES, AND AVAILABILITY OF POLONIUM NEUTRON SOURCES. Information Report. July 1952. Decl. Nov. 29, 1955. 40p. Contract AT-33-1-GEN-53. (MLM-641). $0.25(OTS).

The most commonly used neutron source, Po-Be, is prepared by volatilizing Po into a source container and adding Be in powdered form. These sources are then sealed with Ni or stainless steel coats. Neutron counting and shielding are discussed and tables of neutron yield, Po decay, and α-n energy balance are given. The effects of Po-Be ratios and neutron absorption in absorbents are plotted. (D.E.B.)

2490 CNL-17
[Clinton National Lab., Oak Ridge, Tenn.]
DEVELOPMENT OF A PROCESS FOR PRODUCTION OF RADIUM-BERYLLIUM SOURCES. Final Report. O. Sisman. Jan. 28, 1948. Decl. Nov. 28, 1955. 62p. Contract W-7405-eng-26. $10.80(ph OTS); $3.90(mf OTS).

Development, design, and operation of a process for the production of Ra-Be neutron sources is discussed with emphasis on the mechanisms that are used for carrying out the process by remote control. Two separate installations are used; one for making small, unpelleted sources and the other for making large pelleted sources. Sources containing 25 mg or less of Ra are made by hand in a dry box with a yield of 70 to 100%. Larger sources, containing up to 5 gm of Ra, are made in a large cell which is shielded by 2 ft. of concrete. All operations in the cell are performed using remotely controlled equipment and are viewed through periscopes. Yields for the large sources are near 100%. (auth)

SOURCE PREPARATION - Isotopes 2.45.04

HIGH-INTENSITY Co^{60} GAMMA-RAY SOURCE FOR STUDIES IN RADIATION CHEMISTRY. Presented at the International Conference on Radioisotopes in Scientific Research, Sept. 9-20, 1957 at Paris. No. UNESCO/NS/RIC/20. A. Kh. Brager, V. A. Belynsky, V. L. Karpov, S. D. Prokudin, and V. B. Osipov. London, Pergamon Press, Ltd., 1957. 13p.

A Co^{60} gamma ray source has been developed and built, which is equal to basic present-day standards of radiation chemistry research. 'K-20 000' source is a hollow cylinder (height 250 mm, outside diameter 140 mm, inside diameter 65 mm) containing 56 Co^{60} preparations with a total activity of 21 000 g. equiv. of radium. The source was assembled by means of special devices employing no water shielding. Irradiation is effected in the working chamber (~ $1m^3$) into which the source is introduced with the help of remote control mechanism. The chamber is surrounded with concrete walls 1.5 to 2m. Access into the chamber is gained through a labyrinth. Mechanisms are provided for safe elimination of possible remote control troubles. During intervals between experiments the source is kept in a mobile lead container. (auth)

11522

RADIOACTIVE MATERIALS. (to Isotope Developments Ltd., E. N. Shaw). British Patent 771,294. Nuclear Eng. 2, 350(1957) Aug.

Radioactive cobalt gives rise to γ rays and β rays but usually most of the β radiation is absorbed within the body of the source so that predominantly γ rays emerge. It has been found that the β radiation can be substantially increased by using a thin film of cobalt of a thickness not greater than 0.002 in. Such β radiation is specially useful for determining the thickness of films in the range of 2 to 20 milligrams per sq cm. Although the γ radiation does not present a health hazard, a removable shielding may be convenient. (auth)

7252

AN EMANATING SOURCE FOR I^{132}. D. G. Arnott and C. P. Peruma (London Hospital). Intern. J. Appl. Radiation Isotopes 2, 85-6(1957) Apr.

10113

PREPARATION OF INFINITELY THIN PLUTONIUM SOURCES BY ADSORPTION. M. A. El Guebely and T. Sikkeland (Joint Establishment for Nuclear Energy Research, Kjeller, Norway). Acta Chem. Scand. 11, 473-8 (1957).

Infinitely thin sources have been prepared by adsorption of Pu^{239} from hydrochloric acid solutions onto glass, aluminum, and platinum surfaces. The validity of the method was studied by autoradiography. Results show that glass and aluminum are the best surfaces for such sources of U^{233} on glass. Segregation of Pu and U has been observed on glass as well as on metallic surfaces. (auth)

769 DP-173

Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Augusta, Ga.

THE PREPARATION OF AN AMERICIUM GAMMA SOURCE. Robert C. Milham. Aug. 1956. 10p. Contract AT(07-2)-1. $0.15(OTS).

Americium^{241} was separated from La, Pu, and common metallic elements by ion exchange methods. The purified Am was embedded in plastic and mounted in a holder for use as a γ ray source. (auth)

2974 UR-426

Rochester, N. Y. Univ. Atomic Energy Project.

A NOTE OF PRECISION PLATING OF POLONIUM. Margaret Frisch and Isaac Feldman. Jan. 4, 1956. 9p. Contract W-7401-eng-49. $1.80(ph OTS); $1.80(mf OTS).

Previously published reports leave the impression that the analysis for Po by its spontaneous plating on a metal foil is somewhat inaccurate (best report is ± 5%). The best features of the various published methods were combined to give a procedure which enabled Po recoveries of 99% and better. Possible errors in previous reports are noted. (auth)

3732 CF-45-2-1
Clinton Labs., Oak Ridge, Tenn.
RELATIVE AND ABSOLUTE YIELD FROM ANTIMONY AND LANTHANUM PHOTONEUTRON SOURCES. A. H. Snell. Feb. 6, 1945. Decl. Dec. 20, 1955. 6p. Contract [W-7405-eng-26]. $1.80(ph OTS); $1.80(mf OTS).

Preliminary data are tabulated on photoneutron yields of Be when irradiated by γ rays from Sb^{124} and La^{140}. The results show that for equivalent total γ strength, the Sb produces 47 times as many photoneutrons as the La, while for equivalent millicurie strength, the Sb produces 200 times as many photoneutrons as the La. (B.J.H.)

STRONTIUM 2.46

See also, under WASTE TREATMENT AND DISPOSAL, FISSION PRODUCT REMOVAL (8.05.04).

10915
SEPARATION OF STRONTIUM-90 FROM CALCIUM. P. S. Davis (Australian Atomic Energy Commission, New South Wales). Nature 183, 674-5(1959) Mar. 7.

A study was made of the absorption of calcium and strontium by a cation exchange resin, "Zeo-Karb 225," in the presence of ethylenediaminetetraacetic acid over the pH range 3 to 7. Results indicate that at pH 5.25, strontium, present in cationic form, is quantitatively retained on the resin, while calcium is complexed by the ethylenediaminetetraacetic acid and passes through. This ion-exchange recovery of strontium from strontium-calcium mixtures is achieved with use of very small columns and should be capable of application to the simple determination of strontium-90 on a routine basis, considerably reducing the time required for each determination. (J.H.M.)

RAPID SEPARATION OF RADIOACTIVE STRONTIUM BY SOLVENT EXTRACTION WITH TTA-HEXONE. Toshiyasu Kiba and Shigeru Mizukami (Kanazawa Univ., Japan). Bull. Chem. Soc. Japan 31, 1007-13(1958) Dec.

Radioactive strontium in mixed fission products was rapidly separated by a two-step extraction. The solution of the material was first adjusted to pH 7 and extracted with 0.05 m TTA-benzene. By this treatment rare earths and yttrium were made to go into the organic phase out of the solution. The remaining aqueous phase was transferred into another separatory funnel, adjusted to pH 8, and extracted with 0.05 m TTA-hexone. In this case the radioactive strontium was completely extracted into the organic phase. Less than 5% of ruthenium present in the solution was extracted at the same time. Detailed data of the experiments on the extraction involving the determination of distribution coefficient, and the equilibrium constant were tabulated. (auth)

SOME EXPERIMENTS ON THE Sr^{2+} UPTAKE BY $MnO(OH)_2$. T. Gerevini and E. Lazzarini (Istituto di Fisica Sperimentale del Politecnico, Milan). Energia nucleare (Milan) 5, 831-3(1958) Dec.

Sr^{2+} coprecipitation on $MnO(OH)_2$ was investigated. Removal coefficients were determined as a function of contact time, pH, and strontium concentration. Tracer techniques were employed. (auth)

FISSION PRODUCT SEPARATIONS STUDY. Final Report for the period September 27, 1956-June 30, 1957. R. A. Keeler and C. J. Anderson. Nov. 29, 1957. 47p. (KLX-10089)

The solubility of $SrSO_4$ as a function of temperature and HNO_3 concentration was studied to evaluate this property as a means of separating Sr from radioactive waste. Coprecipitating tests at low and high temperatures were conducted to determine the effectiveness of Ca, Ba, and Pb in scavenging Sr from acid solutions. Several silicate and phosphate minerals were evaluated for their ability to remove Cs and Sr from fission product waste solution. The possibility of extracting slightly soluble cesium picrates from HNO_3 solution by butyl alcohol was investigated with studies of Cs distribution vs. HNO_3 concentration.

STRONTIUM 2.46

EVALUATION OF RADIOCHEMICAL SEPARATION PROCEDURES. Duane N. Sunderman and W. Wayne Meinke (Univ. of Michigan, Ann Arbor). Anal. Chem. 29, 1578-89 (1957) Nov.

Radiochemical separation procedures for Ba, Sr, Ca, and Ag are evaluated. Conditions for optimum radiochemical separation of these three alkaline earths and procedures for systematic separation in tracer solutions are given. Two standard and two new methods for separation of radioactive silver are studied. Effectiveness of ferric and lanthanum hydroxides as scavengers on radioactive tracers is also evaluated. (auth)

379

DEVELOPMENT OF METHODS FOR THE PRODUCTION OF CERTAIN SHORT-LIVED RADIOISOTOPES. Presented at International Conference on Radioisotopes in Scientific Research held Sept. 9-20, 1957 at Paris. No. UNESCO/NS/RIC/190. L. G. Stang, Jr., W. D. Tucker, R. G. Doering, A. J. Weiss, M. W. Greene, and H. O. Banks. London, Pergamon Press, Ltd., 1957. 18p.

Methods are described for the reactor production of Mg^{28}, I^{132}, I^{133}, and F^{18}. Data are included on the decay scheme and half-life of each isotope. A laboratory procedure is described for the separation of Y^{90} from Sr^{90} by elution from a cation exchange resin on which the Sr^{90} has been firmly fixed. (C.H.)

FISSION PRODUCT SEPARATIONS STUDY. QUARTERLY PROGRESS REPORT FOR MARCH 1, 1957-MAY 31, 1957. R. A. Keeler, C. J. Anderson, and M. Kibrick. June 28, 1957. 19p. (KLX-10078)

Decontamination factors of 3440 and 4050 were obtained by coprecipitating Sr with a $BaSO_4$ carrier at 334 and 350°C, respectively, from a 5M HNO_3 solution that initially contained 0.005g of $SrSO_4$/liter and 2g of $BaSO_4$/liter. At higher initial Sr concentrations with both 2 and 6g of $BaSO_4$/liter, the factors were considerably less. Results of the evaluation of several silicate and phosphate minerals for removing Sr and Cs from fission product acid waste liquors indicated that increasing the acidity from 7.0 to 9.0M HNO_3 did not increase the Sr distribution coefficient for the systems under study. A further study of minerals as exchangers or adsorbers of Cs from strong HNO_3 solutions indicated that none of the sixteen minerals tested were particularly good.

7113

INVESTIGATION OF CHEMICAL SEPARATION METHODS FOR Ca AND Sr. QUANTITATIVE DETERMINATION OF BOTH ELEMENTS IN Ca-Sr MIXTURES BY THE ISOTOPIC DILUTION METHOD. G. Leliaert and J. Eeckhaut (Univ. of Ghent, Belgium). Anal. Chim. Acta 16, 311-20 (1957) Apr.

The quantitative separation of Ca and Sr by some of the most interesting chemical procedures has been investigated, using radiochemical tracer techniques. It could be shown that no satisfactory separation could be achieved and good results are obtained in some cases by compensation of errors. The results have been used for the development of an isotopic dilution method for the determination of Ca and Sr in mixtures of their salts. Reliable results are obtained on the semi-micro-scale. (auth)

115

THE RAPID SEPARATION AND DETERMINATION OF RADIOSTRONTIUM AND RADIOCAESIUM IN FISSION PRODUCT MIXTURES. J. C. Dalton and G. A. Welch (U. K. Atomic Energy Authority, Cumberland, England). Anal. Chim. Acta 15, 317-19(1956) Oct.

Anion exchange columns in the hydroxide form have been used to remove all fission products from solution except Sr and Cs (assuming Ba absent). These two elements have been determined in the eluate by precipitation of oxalate and perchlorate respectively. The resulting procedure has been found to be more precise and quicker than others previously used. (auth)

TREATMENT OF WASTES CONTAINING RADIOACTIVE BARIUM, LANTHANUM, STRONTIUM, AND YTTRIUM. J. P. Hutchinson, E. H. Rex, E. R. Mathews, and C. W. Christenson. 1956. 15p. (AECU-3359)

Isotopic components of one of the wastes of a major operating unit of Los Alamos are described and tabled as to half-life and maximum permissible concentration in water. After storage, Sr^{90}, because of its long half-life and very low maximum permissible concentration in H_2O, is the critical component. These conditions indicated the necessity for supplementary treatment for removal of Sr^{90} before final discharge of the waste. Several methods of Sr^{90} treatment before discharge are considered. These are by phosphate coagulation, by lime softening, and by ion exchange materials either alone or in conjunction with chemical precipitation. The ion exchange method, although showing removals of nearly 100% before exhaustion of the resin bed, demonstrated that the quantity of solution which could be decontaminated was controlled by the quality of raw waste

and the depth of the resin column and was, within limits, independent of rate of flow through the column. Experimentation with various combinations and types of ion exchange resins demonstrated that a cation resin, in the acid cycle, would provide an effluent of satisfactory quality in low level wastes, however, the volume and quality of wastes to be treated precluded replacement of resin on exhaustion as economically impractical. Results of a typical regeneration study are presented in tabular form.

179 AECU-3360(Pt. I)
Michigan. Univ., Ann Arbor.
RADIOCHEMICAL SEPARATIONS. I. BARIUM STRONTIUM, AND CALCIUM. Duane N. Sunderman and W. Wayne Meinke. [1955?]. 42p. Contract [AT(11-1)-70]. (M-5783(Pt. I)). $7.80(ph OTS); $3.30(mf OTS).

Radiochemical separation procedures for Ba, Sr, and Ca are reviewed and individual separation steps which are generally applicable are studied to determine optimum conditions. The results are tabulated. (T.R.H.)

THE REMOVAL OF RADIOSTRONTIUM FROM WATER. Edmondo Zamorani and A. Pizziolo. p. 233-47 in "5th International Electronic and Nuclear Review. Acta of the Scientific Congress. Volume I. Nuclear Section." (In Italian)

The factors affecting the removal of radiostrontium from water solutions with sodium phosphate and calcium hydroxide were investigated. The factors studied were acidity of the medium, value of the ratio $Na_3PO_4/Ca(OH)_2$, contact time for the liquid and solid phase, and effect of the molarity of the Sr carrier. The results are graphed and show that the phosphate-calcium method, under some conditions, removes 99% of the strontium activity. Preliminary results from a magnesium phosphate precipitation are given. (J.S.R.)

14389 TID-3529
Technical Information Service Extension, AEC.
REPROCESSING OF IRRADIATED FISSION REACTOR FUEL AND BREEDING MATERIAL. A Literature Search. James M. Jacobs, comp. May 1, 1959. 13p. $0.50(OTS).

Selected unclassified reports on reprocessing fissile and fertile materials are listed which have been received by the Technical Information Service Extension since the preparation of TID-3312, Reprocessing of Irradiated Fission Reactor Fuel and Breeding Materials. The listing contains 119 references to unclassified reports. (A.C.)

13824 WIN-98
National Lead Co., Inc. Raw Materials Development Lab., Winchester, Mass.
LABORATORY INVESTIGATION OF MALLINCKRODT BOMB LINEAR SLAG. E. S. Porter. June 13, 1958. 50p. Contract AT(49-6)-924. $7.80(ph OTS); $3.30(mf OTS).

Data are given for leaching Mallinckrodt magnesium fluoride and dolomite slag in acid and alkaline systems. Recovery of dissolved values is considered using direct precipitation, ion exchange, or solvent extraction. (auth)

7762 ORNL-2477
Oak Ridge National Lab., Tenn.
A SUMMARY OF THE SEPARATION OPERATIONS. M. E. Whatley. Apr. 11, 1958. 102p. Contract W-7405-eng-26. $2.75(OTS).

The subjects discussed are: chemical engineering systems, common concepts used in separation operation, distillation, gaseous diffusion, solvent extraction, and ion exchange. (W.L.H.)

13306
TABLE OF ISOTOPES. D. Strominger, J. M. Hollander, and G. T. Seaborg (Univ. of California, Berkeley). Revs. Modern Phys. 30, No. 2, Pt. II, 585-904(1958) Apr.

A table is presented of a complete list of the radioactive and stable isotopes, with a number of their salient features, as recorded in the literature or by private communications up to February 1958. (W.D.M.)

SURVEYS 2.47

3267 LA-1721(Rev.)
Los Alamos Scientific Lab., N. Mex.
COLLECTED RADIOCHEMICAL PROCEDURES. D. P. Ames, J. W. Barnes, N. A. Bonner, W. H. Burgus, G. A. Cowan, P. B. Elkin, G. P. Ford, J. S. Gilmore, E. J. Lang, M. A. Melnick, C. O. Minkkinen, H. A. Potratz, R. J. Prestwood, J. E. Sattizahn, T. T. Shull, C. W. Stanley,— Jacob Kleinberg, comp. Sept. 10, 1954. Revised Nov. 18, 1955. 287p. Contract W-7405-eng-36. (Deleted version: AECD-3674). $1.50(OTS).

This report supersedes LA-1566, LA-1721, LA-1722, and LA-1567.

The dependency of chemical properties on electronic configuration is discussed. Procedures are presented for the separation from fission products and determination of Be, Na, P, Cl_2, Ca, Sc, Cr, Fe, Co, Ni, Ge, As, Rb, Y, Zr, Nb, Mo, Ru, Pd, Ag, Cd, In, Sn, Sb, Cs, Ba, Ce, Eu, Ta, W, Au, Tl, Th^{230}, Th, Th^{234}, Pa, U^{235}, U^{237}, U, Np, Am, and Cm. (C.W.H.)

9664 ORNL-1706
Oak Ridge National Lab., Tenn.
CHEMICAL SEPARATION OF ISOTOPES SECTION SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1953. June 24, 1954. Decl. Mar. 1, 1957. 18p. Contract W-7405-eng-26. $3.30(ph OTS), $2.40(mf OTS).

The work on chemical separation of isotopes has been reactivated during this period. A proposed system for the separation of the isotopes of hydrogen and chlorine by means of tetrahydrofuran and hydrogen chloride has been investigated and has been shown to be chemically infeasible. Studies of the chlorine(gas) vs. chloride ion(aqueous) system have been initiated. Nitrous acid is presently being used as the refluxing agent in column studies of the isotopic separation factor. Results are reported on an exchange study in which Cl^{36} is used. No exchange of chlorine was found between chlorate and perchlorate ions in water solution after two years at room temperature. Hydrated lithium ions have been found to exchange all their molecules of solvation in a half-time of less than 0.8 min. Oxygen-18 was used as a stable isotopic tracer in this experiment. Methods of boron isotope separation have been examined. A liquid–liquid system using boric acid and fluoboric acids distributed between an aqueous phase and an organic phase composed of a mixture of benzene and di(2- ethylhexyl) amine has been investigated, and results on distributions are presented. A gas-liquid type of system is proposed. Investigations are in progress on modifications of the ammonia(gas) vs. ammonium ion(aqueous) system for nitrogen isotope enrichment. An exchange column, stripping column, and associated apparatus have been built. Runs on this system show that calcium hydroxide slurry may be substituted for sodium hydroxide solution as the refluxing agent to convert ammonium ion to ammonia gas at the product (N^{15}) end of the system. This substitution should cut the cost of reflux chemicals considerably. A proposed closed-cycle system which would eliminate or greatly reduce the cost of reflux chemicals is under investigation. This system uses ammonium carbonate in place of ammonium nitrate in the aqueous solution. Initial difficulty has been encountered in plugging of the exchange column by a precipitate. Further runs are planned. (auth)

6461 A/CONF.15/P/1323
RADIOCHEMICAL STUDIES OF FISSILE AND FISSION-PRODUCED ELEMENTS. Nobufusa Saito, Toshiyasu Kiba, and Kenjiro Kimura (Japan). 72p.

Recent radiochemical studies in Japan concerning fissionable and fission-produced elements are summarized. Separation procedures and the reactions involved are discussed. The procedures discussed are solvent extraction, ion exchange, coprecipitation, volatilization, electrolysis, and paper chromatography. Elements under consideration include Cs, Sr, Ba, Zr, Nb, Ru, Rh, Te, Sb, rare earths, and a few actinide elements, i.e., Th, U, and Np. Special attention is directed to Cs^{137} and Sr^{90}. (W.D.M.)

SURVEYS 2.47

16308
PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON ISOTOPE SEPARATION HELD IN AMSTERDAM, APRIL 23-27, 1957. J. Kistemaker, J. Bigeleisen, and A. O. C. Nier, eds. Amsterdam, North-Holland Publishing Company, 1958. 723p.

Papers presented at the International Symposium on Isotope Separation held in Amsterdam, 1957, and the pertinent discussions are presented. Papers in English, French, and German are included in the fields of chemical engineering, molecular interactions, chemical exchange, electromigration, distillation, thermal diffusion, diffusion, electromagnetic separation, and the development of ultracentrifuges. (C.H.)

6450
PRODUCTION AND ANALYSIS OF ISOTOPES. W. Walcher. Naturwissenschaften 44, No. 6, 132-44(1957). (In German)

11572
RADIOACTIVE ISOTOPES: THEIR PRODUCTION AND APPLICATION. Kurt Schmeiser. Berlin, Springer-Verlag, 1957. 255p. (In German)

A brief survey of atomic structure and the production of artificial radioisotopes serves as an introduction to a detailed study of radiation detection instruments. The ionization chamber, Geiger-Mueller tube, proportional counter, and scintillation counter are discussed. The impulse amplifier is briefly mentioned. The passage of beta, gamma, and alpha radiation through matter and the detection of each is treated separately. Absolute measurements of radioactivity are discussed. Methods, applications, and advantages of autoradiography are described. The effects of radiation, protection against it, and the laboratory equipment needed for work with radioisotopes are then reviewed. The book closes with a survey of the applications of radioisotopes to chemistry, medicine, biology, geology, mineralogy, and other technical fields. (J.S.R.)

4555
ISOTOPES. Joseph Silverman (Radiation Applications Inc., New York) and Karl Cohen (General Electric Co., San Jose, Calif.). Ann. Rev. Phys. Chem. 7, 335-58(1956).

A review of the subject of isotopes in physical chemistry is presented. The subjects included are: Instruments and Methods; Atomic Mass Measurements; Relative Abundance and Isotope Geochemistry; Isotope Separation; Isotope Effects in Equilibrium Phenomena; Chemical Kinetics; and Mass Spectra. (T.R.H.)

THE DEVELOPMENT AND EVALUATION OF RADIOCHEMICAL SEPARATION PROCEDURES FOR BARIUM, CALCIUM, STRONTIUM, SILVER, AND INDIUM. Duane N. Sunderman. Feb. 22, 1956. 213p. (AECU-3159)

The objective of this research was to conduct a program of development and critical evaluation of radiochemical separation procedures. Procedures for individual elements reported in the literature were collected and subdivided into individual separation steps. Those steps which were found to be unique and to possess general applicability were studied experimentally to determine optimum conditions (of both yield and decontamination) for separation. These steps were then further evaluated under optimum conditions to determine the effects on the separation of a number of diverse but representative elements and materials.

4063 ORNL-2064
Oak Ridge National Lab., Tenn.
RADIOISOTOPE PRODUCTION AND PROCESS DEVELOPMENT. Annual Report for 1955. A. F. Rupp. (Compiled from Data by E. E. Beauchamp, J. H. Gillett, and E. J. Witkowski). May 3, 1956. 22p. Contract W-7405-eng-26. $3.30(ph OTS); $2.40(mf OTS).

Production and process development activities during the calendar year 1955 are summarized. Twelve thousand seven hundred and fortv-nine shipments were made. The quantity of activity shipped increased from 28,879 c in 1954 to 49,383 c in 1955. The increase resulted from a trend to larger quantities per package and increases in shipments of Co^{60} and Cs^{137} for large irradiation units. Major developments during the period included: improved techniques for handling, assaying, and fabricating sources of over 10,000 c of Co^{60} per batch; separation of Am^{241} from Pm^{147} by ion ex-

7589
RADIOCHEMICAL SEPARATION TECHNIQUES. H. L. Finston and John Miskel (Brookhaven National Lab., Upton, N. Y.) Ann. Rev. Nuclear Sci. 5, 269-96(1955).

The following techniques for the separation of radioisotopes are reviewed: precipitation, solvent extraction, volatilization, and chromatography. The application of various instruments (γ spectrometers and α pulse-height analyzers) to isotope identification is also discussed. 104 references. (C.W.H.)

SURVEYS 2.47

4524 NP-7134
Brussels. Centre d'Étude de l'Énergie Nucléaire.
REACTIONS NUCLEAIRES, PREPARATION DES RADIOELEMENTS ARTIFICIELS ET APERCU DES POSSIBILITES D'APPLICATIONS. (Nuclear Reactions, Preparation of Artificial Radioelements and Survey of Possibilities of Application.) R. Constant. Jan. 15, 1958. 26p.

The physics of nuclear reactions is discussed in relation to production of radioisotopes. The uses of radioisotopes in science and industry are surveyed. (T.R.H.)

14699 A/CONF.15/P/831
Oak Ridge National Lab., Tenn.
FISSION PRODUCT PILOT PLANT AND OTHER DEVELOPMENTS IN THE RADIOISOTOPE PROGRAM AT THE OAK RIDGE NATIONAL LABORATORY.

E. Lamb, H. E. Seagren, and E. E. Beauchamp. 14p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

A survey is given of the plant and process improvements incorporated into the program from 1955 until the present time. A major addition to the production capacity of separated long-lived fission products was made by the completion of the Fission Product Pilot Plant, which has a designed annual capacity of 200,000 curies of Cs^{137}. Comparable amounts of the other fission products, Sr^{90}, Ru^{106}, Ce^{144}, Pm^{147}, and Tc^{99}, will also be separated from aqueous wastes resulting from irradiated uranium recovery processes. Short-lived fission product production has been increased by the addition of equipment in which Zr^{95}-Nb^{95}, Ba^{140}, Nd^{147}, Pr^{143}, Sr^{89}, Ce^{141}, and Ru^{103} are recovered from the uranium solution remaining after the distillation of I^{131} Other short-lived radioisotopes with half-lives as short as 12.44 hours are produced by processing irradiated material. The radioactive noble gases, Xe^{133} and Kr^{85} have also been made available in greater quantities by the use of improved equipment. In general, radioisotope production has grown from 30,000 curies per year in 1955 to over 120,000 curies at the present time, and in the same period the average shipment has increased from 2,000 to 10,000 mc. (auth)

ISOTOPIC MIXTURES. I. Prigogine and A. Bellemans (Univ. of Brussels). Nuovo cimento (10) 9, Suppl. No. 1, 342-4(1958).

An equation is developed which shows that the excess free energy of a mixture of two isotopes is approximately equal to the work spent in changing the molar volumes of the two components into the molar volume of the mixture ($g^E \simeq g^M$). (D.E.B.)

13839
THE ISOLATION OF RADIOACTIVE ISOTOPES WITHOUT CARRIERS. N. P. Rudenko. Zhur. Neorg. Khim. 3, 167-74(1958). (In Russian)

A survey is given of the methods used for the isolation of radioisotopes without carriers. The methods used in the Research Institute for Nuclear Physics of the Moscow State University are discussed in detail. 18 references. (J.S.R.)

9987 ORNL-2303
Oak Ridge National Lab., Tenn.
RADIOISOTOPE PRODUCTION AND PROCESS DEVELOPMENT ANNUAL REPORT FOR 1956. H.E. Seagren. July 11, 1957. 18p. Contract W-7405-eng-26. $0.20(OTS).

The main radioisotope production and process developments during the year 1956 are summarized. Chloroplatinic acid was investigated as a reagent for the final purification and recovery of fission product Cs^{137}. Cesium carried from simulated Arco wastes on 0.01M nickel ferrocyanide was studied for the best separation method. The reduction of Hg in Redox wastes was studied. Remotely operated shielded-arc welding for sealing stainless steel containers has been demonstrated successfully. (M.H.R.)

TABLES OF THE "V" FUNCTIONS. C. L. Childress and H. E. Hanthorn, comps. May 22, 1957. 191p. (HW-51820)

In calculations related to isotope separation, the concept of separative work is used as a measure of the plant capacity and energy input required to produce a given amount of isotope separated to a certain product specification. The separative work is given by $\Delta = PV(x_p) + WV(X_w) - FV(x_f)$. The function of concentration x denoted by $V(x) = (2x-1) \ln x/1-x$. A second function much used in isotope separation calculations is the derivation of $V(x)$ with respect to x, $V'x = 2x-1/x(1-x) + 2 \ln x/1-x$. Values of $V(x)$ and $-V'(x)$ are tabulated from $x = 0$ to $x = 0.5$.

TECHNETIUM 2.48

DEVIATIONS FROM PLATE THEORY IN THE ION-EXCHANGE SEPARATION OF TECHNETIUM AND RHENIUM. R. N. Sen Sarma, Edward Anders, and J. M. Miller (Univ. of Chicago and Columbia Univ., New York). J. Phys. Chem. 63, 559-65(1959) Apr.

Technetium and rhenium in their highest oxidation states can be separated by ion-exchange chromatography on the synthetic resin Dowex 1, using perchlorate ion as the elutriant. In 0.1 and 0.2 f $HClO_4$ solutions, the peak elution volumes (in units of free column volumes) are 43.0 ± 0.8 and 23.6 ± 0.4 for ReO_4^-, and 85.2 ± 1.9 and 43.7 ± 0.7 for TcO_4^-, respectively. The trailing edges of the elution curves deviate markedly from the predicted Gaussian shape, and the observed separation factors differ from those calculated from the plate theory of Mayer and Tompkins, and Glueckauf, by factors of 10^2 to 10^{18}. Part of the discrepancy is due to a chemical cause, presumably radiocolloid formation, and can be eliminated by appropriate chemical treatment. In addition, there appears to be a "residual" tailing-effect which can be reduced, but not eliminated, by changing the experimental variables. This effect, which appears to arise from the infrequent occurrence of a second, slow exchange process, limits the maximum separation factors attainable to 10^4–10^5, irrespective of the number of theoretical plates. The mechanism of this process could not be established with certainty, although its dependence on flow rate was consistent with the behavior expected if the chemical exchange reaction with the exchange site, rather than film or particle diffusion was the rate-determining step. It appears that the "residual" tailing-effect is not limited to the two elements studied, but occurs in other systems as well. At high acid concentrations, a broadening and distortion of the technetium peaks was observed, indicating oxidation of the resin by pertechnetate. (auth)

13842

ISOLATION OF TECHNETIUM-99m WITHOUT CARRIER BY MEANS OF BREAKING CHEMICAL BONDS DURING β-DECOMPOSITION. V. D. Nefedov and M. A. Toropova. Zhur. Neorg. Khim. 3, 231-4(1958). (In Russian)

A new method for the isolation of carrier-free Tc^{99m} by extraction from chloroform solution of $Mo/Mo^{99}/(Co)_6$ is described. The possibility of applying this method to the isolation of other radioisotopes is discussed. (J.S.R.)

PRODUCTION OF WEIGHABLE AMOUNTS OF Tc^{99} BY NEUTRON IRRADIATION OF MOLYBDENUM. V. I. Spitsyn and A. F. Kuzina. Atomnaya Energ. 5, 141-6 (1958). (In Russian)

Various methods of technetium recovery from molybdenum anhydrides, irradiated by thermal neutrons in nuclear reactor, were studied. A method for technetium concentration and recovery was developed by coprecipitation of technetium with phosphate followed by chromatographic purification. The laboratory method succeeded in producing several milligrams of Tc^{99}. Spectral analysis was made for identification of the recovered technetium, and measurements were made of the absolute activity and its β-ray energy maximum. The chemical properties of technetium were studied. (tr-auth)

3659 AEC-tr-3490

EXTRACTION METHOD FOR THE SEPARATION OF TECHNETIUM FROM IRRADIATED MOLYBDENUM. M. S. Faddeeva (Faddeev), O. N. Palov, and V. V. Bakunina. Translated for Oak Ridge National Lab. from Zhur. Neorg. Khim. 3, 165-6(1958). 4p.

The extraction of technetium from irradiated molybdenum using methyl-ethyl ketone is examined. The distribution coefficient of Tc between K_2CO_3 solution and methyl-ethyl ketone is much larger than is the case when pure water is used with the ketone. Molybdenum has the same salting-out effect; however, an increase in the K_2CO_3 concentration in the presence of large amounts of molybdenum in solution decreases the distribution coefficient for Tc. These considerations were applied in obtaining the 6-hour Tc^{99m} isomer. Methods of Tc identification and separation efficiency are discussed, and it is concluded that about 1 mg of Tc can be separated with a calculated purity of about 75 to 80%.

TECHNETIUM 2.48

~~13057~~
SEPARATION OF TECHNETIUM FROM RHENIUM BY ELECTROPHORESIS AND PAPER CHROMATOGRAPHY. Rodrigo Alberto Guedes de Carvalho. Thesis, Universidade do Porto, Portugal, 1958. (In Portuguese)

The known facts on the physical and chemical properties of technetium are reviewed, including the separation of technetium from other elements and its determination. The theoretical considerations of paper electrophoresis and chromatography are discussed. The experimental procedures are described in detail, and the results are given. A special study was made of the reduction and complex formation of rhenium. 66 references.

13840
USE OF CARBONYLS FOR THE ISOLATION OF THE RADIOISOTOPES Cr^{51}, Mo^{99}, W^{187}, Tc^{99m}, AND Re^{188} V. D. Nefedov and M. A. Toropova. Zhur. Neorg. Khim. 3, 175-80(1958). (In Russian)

The carbonyls of Cr, Mo, and W were used as irradiation products since the carbonyls are easily purified and resistant to irradiation. After a short irradiation, the crystals were dissolved in chloroform and the isotopes extracted with water. The yields were 30, 34, and 55% for W, Mo, and Cr, respectively. The use of carbonyls for the separation of Tc^{99m} and Re^{188} was also investigated. Both isotopes were obtained without carrier and were radiochemically pure. (J.S.R.)

19955 CEA-tr-R-703
SÉPARATION DU TECHNÉTIUM-99m SANS ENTRAÎNEUR PAR LA MÉTHODE DE RUPTURE DE LA LIAISON CHIMIQUE LORS DE LA DÉSINTÉGRATION β. (Separation of Carrier-Free Technetium-99m by the Method of Chemical Bond Breaking During β Disintegration.) V. D. Nefedov and M. A. Toropova. Translated into French from Zhur. Neorg. Khim. 3, 231-4(1958). 11p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 13842.

~~9999~~ AERE-C/M-96
Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.
TRACER EXPERIMENTS ON TECHNETIUM. F. Morgan, M. L. Sizeland, and H. H. Willis. Dec. 21, 1950. 15p.

The results of experiments on the solvent extractability, behaviour with ion exchangers, and coprecipitation reactions of Tc^{99} are described. (auth)

6396 A/CONF.15/P/1810
SEPARATION OF TECHNETIUM FROM RHENIUM BY PAPER ELECTROPHORESIS. Rodrigo Alberto Guedes de Carvalho (Comissão de Estudos da Energia Nuclear, Porto, Portugal). 5p.

The electrophoretic separation of rhenium from technetium was achieved by reduction of Tc (VII) to Tc (IV) which is cationic or does not migrate, while Re (VII) is not affected by the reductant and maintains its anionic character. Among several reductants studied buffered solutions of hydrazine hydrate and sulfate (pH = 8 to 9) and hydriodic acid permitted very good and rapid separations of the two elements. (auth)

TELLURIUM 2.49

20910 CEA-tr-X-148
SÉPARATION DE TELLURE D'AVEC L'IODE PAR EXTRACTION DANS LE PHOSPHATE DE TRIBUTYLE 100 POUR CENT. (Separation of Tellurium from Iodine by Extraction with 100% Tributyl Phosphate.) Mariko Inarida (Inanida). Translated into French by S. S. Minn from Nippon Kagaku Zasshi 79, 721-3(1958). 11p.

The use of 100% TBP in the solvent extraction of iodine from tellurium was investigated. The study showed that the addition of hydrogen peroxide to an aqueous solution with an HCl concentration of 0.2N oxidizes the iodine ions which can then be completely extracted with 100% TBP. If the aqueous layer is then adjusted to 4N, a new extraction with 100% TBP removes the Te^{4+} ions, and the Te^{6+} ions remain in the aqueous layer. The three ions can thus be separated quantitatively. (tr-auth)

TELLURIUM 2.49

13841
THE SEPARATION OF THE NUCLEAR ISOMERS OF TELLURIUM, MERCURY AND TIN. A. N. Murin, V. D. Nefedov, E. N. Sinotova, and O. V. Larionov. Zhur. Neorg. Khim. 3, 181-3(1958). (In Russian)
Methods for the separation of the isomers of tellurium, mercury, and tin were investigated. Metalloörganic compounds were prepared, and as a result of isomeric transitions the chemical bonds were broken. The isomers in the ground state formed simple inorganic compounds and were removed. (J.S.R.)

4371
THE SEPARATION OF CARRIER-FREE TELLURIUM TRACERS BY PAPER CHROMATOGRAPHY. A. S. Ghosh Mazumdar and M. Lederer. J. Inorg. and Nuclear Chem. 3, 379-83(1957) Jan.
Paper chromatographic conditions for the purification of carrier-free Te tracers (from Zr tracer and from Cu in macro quantities), as well as for the separation of Te^{4+} and Te^{6+} ions, have been established. The low R_F values of Te^{6+} in butanol/HCl mixtures have been explained by the tendency of telluric acid to polymerization. (auth)

TIN 2.50

6305
CARRIER-FREE SEPARATION OF Sn^{113} FROM INDIUM. K. S. Bhatki and P. Radhakrishna (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci. 45, 30-4(1957) Jan.
A procedure for the separation of carrier-free Sn^{113} from deuteron bombarded In is described. The method employed depends on the extraction of stannic cupferrate from mineral acid solution using CCl_4, followed by ignition of the complex. (auth)

XENON 2.51

See also, under FISSIONABLE MATERIAL RECOVERY, HEAD-END TREATMENTS--Off-Gas (3.01.06).

14267 UCRL-8755
California. Univ., Berkeley. Lawrence Radiation Lab.
ADSORPTION OF XENON IN AN ACTIVATED CHARCOAL COLUMN. H. P. Cantelow. May 11, 1959. 29p. Contract W-7405-eng-48. $4.80(ph), $2.70(mf) OTS.
Performance characteristics of two activated charcoal columns at room temperature in separating fission-product xenon from an air stream were investigated by installing each column in the exhaust from an enclosure in which irradiated slugs were dissolved. Breakthrough curves are presented and the variation in xenon concentration within the columns is examined. Theoretical treatments of adsorption columns in the literature are found to agree well with the experimental data. Performance of the columns is evaluated in terms of "concentration factor" and number of effective theo-

10778 WAPD-PWR-CP-1717
Westinghouse Electric Corp. Bettis Plant, Pittsburgh.
STRIPPING OF TRACE AMOUNTS OF Xe^{133} FROM AQUEOUS SOLUTION. A. S. Kesten. Jan. 18, 1956. 7p. Contract AT-11-1-GEN-14. $1.80(ph OTS); $1.80(mf OTS).
The rate of O_2 removal from a water solution is about the same or greater than Xe removal in a stripping operation. Results demonstrate that gross deviations, in the rate of Xe^{133} stripping, from expected rates do not exist. (F.S.)

7345 BNL-3337
Columbia Univ., New York.
SOLUBILITY AND STRIPPING OF RARE GASES IN MOLTEN METALS. Final Report. June 30, 1955. 16p. For Brookhaven National Lab. Subcontract S-229. (CU-4-56-BNL-S229-Ch.E.) $3.30(ph OTS); $2.40(mf OTS).
The status of the work on solubility and stripping of xenon in molten bismuth at the end of the subcontract period is described. The experimental procedures have been improved to the point where they are entirely reliable. The results show the solubility of xenon in bismuth at 492°C to be 8×10^{-7} atom fraction at atmospheric pressure. Various theoretical predictions of the solubility range from 100 times this result to 10^{-17} times this result, are evidently entirely useless for obtaining reliable values. (auth)

4322 ORNL-793
Oak Ridge National Lab., Tenn.
DECONTAMINATION OF XENON FROM RADON. H. Zeldes and A. R. Brosi. Aug. 14, 1950. Decl. Jan. 5, 1956. 9p. Contract W-7405-eng-26. $1.80(ph OTS); $1.80(mf OTS).

The feasibility of rapidly decontaminating liter amounts of Xe from Rn by factors of at least 10^6 using a simple gas chromatography technique has been demonstrated. The separation has been achieved in a single pass through a small synthetic hydroxyapatite column with high recovery. A method is also indicated for quantitatively recovering the Xe in a given sample in decontaminated form. (auth)

2472 LAMS-769
Los Alamos Scientific Lab., N. Mex.
ISOLATION OF HIGH ACTIVITIES OF Xe^{135} AT THE OMEGA WATER BOILER. Nathan Sugarman. Aug. 18, 1948. Decl. Dec. 9, 1955. 7p. Contract [W-7405-eng-36]. $1.80(ph OTS); $1.80(mf OTS).

Experiments were made to test the feasibility of isolating high-activity Xe^{135} samples necessary for cross section measurements. The procedure for the preparation of Xe samples is described in detail. Results show that 94% of the activity at the time of isolation was Xe^{135}. Activities of the samples were about 30 curies. (B.J.H.)

7289 A/CONF.15/P/1124
THE SEPARATION OF XENON AND DEUTERIUM BY THERMAL DIFFUSION. D. Heymann (Foundation for Fundamental Research of Matter, Amsterdam). 25p.

A nuclear reactor of the suspension type is characterized by the fact that the fission products will continuously escape from the nuclear fuel and travel through the ensemble of fuel and moderator. Among these products, xenon isotopes are relatively important, and the separation of these isotopes from deuterium is one of the engineering problems connected with the maintenance of this reactor. Thermal diffusion separation in the gaseous phase offers a promising method for the extraction of xenon at very low concentrations without the addition of auxiliary components and with a minimum effort with respect to constructional considerations. The extraction can be performed even at higher pressures without the use of coolants, adsorbents, and pumps. Hence, it seemed worth while to investigate the properties of the mixtures. The thermal diffusion factor of xenon in deuterium has been determined at different temperatures, using the "two-bulb technique." At about 340°K it is of the order of +0.50. Xe^{133} was added in tracer quantities to the deuterium gas. Subsequently, an experimental thermal diffusion column of the hot wire type was designed and constructed, and the transport properties of this cascade were studied. It was found that the transport follows the theory quantitatively fairly well but is essentially smaller than the value expected by theory. A calculation of a column of the concentric cylinder type is tentatively given, using the results of the previous investigations. (auth)

YTTRIUM 2.52

16086 ANL-6011
Argonne National Lab., Lemont, Ill.
PREPARATION OF YTTRIUM FLUORIDE IN FLUIDIZED BEDS. Irving E. Knudsen and Norman M. Levitz. May 1959. 14p. Contract W-31-109-eng-38. $0.50 (OTS).

The batch fluid-bed hydrofluorination of yttrium oxide to yttrium fluoride of low residual oxygen content was studied in a 3-inch Monel column. Bed temperature, hydrofluorination time, and hydrofluoric acid excess were studied, and the contamination due to equipment corrosion was determined. A sample of the fluoride was converted to metal and analyzed for impurities. A brief investigation of the reaction kinetics was also made on the thermobalance. (auth)

13222 ISC-1118
Ames Lab., Ames, Iowa.
SEMI-ANNUAL SUMMARY RESEARCH REPORT IN ENGINEERING FOR JULY–DECEMBER 1958. Apr. 15, 1959. 36p. Contract W-7405-eng-82. $1.00(OTS).

Chemical Engineering. A tributyl phosphate–water–nitric acid system is being used for separating N^{15} and N^{14} by solvent extraction. A forced convection loop for circulating Pb–Bi mixtures is discussed. The production of low oxygen content YF_3 is reported. Various container materials for the Ag–U alloy were tested. A process has been developed for the recovery of Y

YTTRIUM 2.52

wastes. Nuclear Engineering. The design of the subcritical nuclear assembly to use an aqueous slurry of uranium oxide has been completed and a prototype constructed. Capsule tests of the Th–Mg eutectic in Nb metal were run for periods of 1000 hrs and 1300 hrs at 850°C with no appreciable attack of the Nb. Ceramic Engineering. The high-temperature strength characteristics of $MgO-CaF_2$ system are reported. A fundamental investigation of the oxidation of $MoSi_2$ has established that $MoSi_2$ is protected against rapid oxidation at high temperatures by the formation of a surface film. Work was begun on a porcelain-enamel coating for Y which would protect it from oxidation at temperatures up to 1000°C. (For preceding period see ISC-1051.) (W.L.H.)

New Brunswick Lab., AEC, N. J.
SOLVENT EXTRACTION CONCENTRATION OF CERTAIN RARE EARTHS IN YTTRIUM. A. R. Eberle and M. W. Lerner. Oct. 1957. Decl. July 24, 1959. 10p. $1.80(ph), $1.80(mf) OTS.

A procedure is given for the concentration of gadolinium, dysprosium, and samarium in yttrium oxide by extraction of the thiocyanates with tributyl phosphate. Concentration of these elements up to 80-fold was obtained. Results are given on the effects of ammonium thiocyanate and tributyl phosphate concentrations, as well as pH, temperature, and sample size on the separation. Analyses of standard yttrium oxide samples after concentration of these rare earths are in good agreement with results obtained by direct spectrographic analyses. (auth)

379
DEVELOPMENT OF METHODS FOR THE PRODUCTION OF CERTAIN SHORT-LIVED RADIOISOTOPES. Presented at International Conference on Radioisotopes in Scientific Research held Sept. 9-20, 1957 at Paris. No. UNESCO/NS/RIC/190. L. G. Stang, Jr., W. D. Tucker, R. G. Doering, A. J. Weiss, M. W. Greene, and H. O. Banks. London, Pergamon Press, Ltd., 1957. 18p.

Methods are described for the reactor production of Mg^{28}, I^{132}, I^{133}, and F^{18}. Data are included on the decay scheme and half-life of each isotope. A laboratory procedure is described for the separation of Y^{90} from Sr^{90} by elution from a cation exchange resin on which the Sr^{90} has been firmly fixed. (C.H.)

380

1310
ANION EXCHANGE BEHAVIOUR OF YTTRIUM. Nobufusa Saito and Tatsuya Sekine (Univ. of Tokyo). Nature 180, 753(1957) Oct. 12.

8876
THE SEPARATION OF CARRIER-FREE Y^{90} FROM Sr^{90} BY ELECTROLYSIS. Gerald Lange, Günter Herrmann, and Fritz Starssmann. J. Inorg. and Nuclear Chem. 4, No. 3 and 4, 146-54(1957). (In German)

The electrolytic deposition of Y^{90} from weak aqueous HNO_3 for the separation of carrier-free Y^{90} from Sr^{90} has been investigated. The Y^{90} is deposited on the cathode with a yield of 90 to 98%. Through repetition of the electrolysis, Y^{90} can be prepared with less than 10^{-4}% Sr^{90}. (auth)

2831
SEPARATION OF STRONTIUM-90 AND YTTRIUM-90 AND THE PREPARATION OF CARRIER-FREE YTTRIUM-90. David Dyrssen (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Chem. Scand. 11, 1277-8(1957).

2832

11354
CHROMATOGRAPHIC SEPARATION OF RADIOELEMENTS OF THE YTTRIUM GROUP OF ELEMENTS OBTAINED DURING FISSION OF YTTERBIUM AND HAFNIUM BY HIGH ENERGY PROTONS. A. A. Pozdyakov (V. I. Vernadsky Inst. of Geochemistry and Analytical Chemistry). J. Anal. Chem. U.S.S.R. (English Translation) 11, 605-10(1956) Sept.-Oct.

This paper was previously abstracted from the original language and appears in NSA, Vol. 11, as abstract No. 1834.

4369
PREPARATION OF CARRIER-FREE YTTRIUM-90 BY PAPER CHROMATOGRAPHY. Toshiyasu Kiba, Shigeru Ohashi, and Satoshi Tada. Bull. Chem. Soc. Japan 29, 745-8(1956) Sept.

Carrier-free, 99.9% Y^{90} can be separated rapidly and simply from Sr^{90} by paper chromatography. The solvent used was C_2H_5OH with NH_4SCN. (auth)

See also, this section,

NIOBIUM (2.32),

and,

under PROCESS CHEMISTRY AND ENGINEERING,

SPECIAL PROCESSES--HCl-Alcohol (6.17.12)

Zircex (6.17.24),

Zirflex (6.17.25),

Purex (6.17.17),

DeBoer (6.17.05).

ZIRCONIUM- Ion Exchange 2.53.01

19873

SEPARATING ZIRCONIUM AND NIOBIUM BY REVERSED-PHASE PARTITION CHROMATOGRAPHY. S. Sekerskiĭ and V. Kotlinskaya (Inst. of Nuclear Research, Academy of Sciences, Warsaw). Atomnaya Energ. 7, 160-2(1959) Aug. (In Russian)

Separation of zirconium and niobium was achieved by reverse-phase partition chromatography using tributyl phosphate sorption on silica gel. (R.V.J.)

19872

SORPTION METHODS OF SEPARATING BARIUM FROM RADIUM, ALUMINUM FROM GALLIUM, AND ZIRCONIUM FROM HAFNIUM. B. N. Laskorin, V. S. Ulyanov, R. A. Sviridova, A. M. Arzhatkin, and A. I. Yuzhin. Atomnaya Energ. 7, 110-16(1959) Aug. (In Russian)

An effective chromatographic separation method was achieved by using complex-forming substances capable of reducing the active concentration forces in ions subjected to separation. In the first approximation such separation amounts to reduction of the number of elements. The difference in complex-forming constants increases the separation coefficient. Optimum conditions were found, using various complex-forming elements, for separating barium and radium, zirconium and hafnium, and aluminum and gallium. The efficiency of the methods is 15 to 60 kg/hr per m^2 of the scale. (tr-auth)

10886

BEHAVIOR OF ZIRCONIUM-95 AND NIOBIUM-95 IN DILUTE HYDROCHLORIC ACID TOWARD CATION EXCHANGE RESIN. Seishi Yajima (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan 31, 699-704(1958) Sept.

By passing 0.2N hydrochloric acid solution of tracer amounts of Zr^{95} and Nb^{95} (about 10^{-11} mole/l, 10^{-13} mole, or 1 μc, with respect to each nuclide) through a cation exchange resin column (Dowex 50-X8, Amberlite IR-120, or Diaion SK) and eluting with 0.2N hydrochloric acid, a fraction containing mainly Nb^{95} was obtained. A fraction containing mainly Zr^{95} was then obtained by eluting with 0.5% oxalic acid or 3N hydrochloric acid. With higher concentrations of nonactive zirconium and niobium (about 10^{-6} mole/l each), similar results were also obtained. As the 0.2N hydrochloric acid solution of $Zr^{95}-Nb^{95}$ became aged, the adsorbability of Zr^{95} decreased. Effect of hydrochloric acid concentration on the adsorbability of Zr^{95} and Nb^{95} was studied, and the concentration range 0.1 to 0.3N was found to be suitable for separation. The adsorbability of Nb^{95} increased with an increase in the concentration of strontium ion. (auth)

SEPARATION OF TITANIUM FROM ACCOMPANYING ELEMENTS BY ION-EXCHANGE CHROMATOGRAPHY. 3. SEPARATION OF TITANIUM AND ZIRCONIUM. T. A. Belyavskaya, I. P. Alimarin, and I. F. Kolosova (Lomonosov Moscow State Univ.). Zhur. Anal. Khim. 13, 668-70(1958) Nov.-Dec. (In Russian)

Distribution coefficients of tetravalent titanium and zirconium between ion-exchange resins and hydrochloric acid solutions of various concentrations were determined. It was found that there is no sorption of the mentioned elements from 0.1 to 6 N hydrochloric acid solutions with anion exchange resins. A method was developed for the quantitative chromatographic separation of titanium and zirconium over the range of ratios Ti:Zr from 1000:1 up to 1:10,000 by means of a hydrochloric acid solution on the cation exchange resin.

ZIRCONIUM - Ion Exchange 2.53.01

13734
APPLICATION OF ION EXCHANGE IN THE STUDY OF THE STATE OF SUBSTANCES IN SOLUTION. V. INVESTIGATION ON THE PROCESS OF THE FORMATION OF COMPLEXES OF ZIRCONIUM WITH NITRIC ACID. V. I. Paramonova and A. N. Sergeev. Zhur. Neorg. Khim. 3, 215-21(1958). (In Russian)

Zirconium in nitric acid solution forms complexes both by hydrolysis and nitration. Conditions for the hydrolysis of Zr were determined, and the formation of nitrate complexes were studied by means of ion exchange. (J.S.R.)

4584
SEPARATING HAFNIUM FROM ZIRCONIUM. B. A. J. Lister, J. F. Duncan, and J. M. Hutcheon (to U. S. Atomic Energy Commission). U. S. Patent 2,759,792. Aug. 21, 1956.

Substantially complete separation of zirconium from hafnium may be obtained by elution of ion exchange material, on which compounds of the elements are adsorbed, with an approximately normal solution of sulfuric acid. Preferably the acid concentration is between 0.8 N and 1.2 N, and should not exceed 1.5 N. Increasing the concentration of sulfate ion in the eluting solution by addition of a soluble sulfate, such as sodium sulfate, has been found to be advantageous. The preferred ion exchange materials are sulfonated polystyrene resins such as "Dowex 50," and are preferably arranged in a column through which the solutions are passed.

2353 NYOO-1450
Ionics, Inc., Cambridge, Mass.
FINAL REPORT FOR JULY 5, 1949 TO OCTOBER 31, 1949. Oct. 31, 1949. Changed from OFFICIAL USE ONLY Aug. 24, 1956. 9p. Contract AT(30-1)-665. $1.80(ph OTS); $1.80(mf OTS).

Anion-exchange separation on Dow A-2 resin of mixed $ZrF_6^{-2}-HfF_6^{-2}$ solutions was carried out. No significant separation was achieved by the use of conventional elution techniques. Separations yielding 70 to 80% Zr containing Hf/Zr ratios 65 to 75% of originals were achieved through the use of combined precipitation-development on a single column with 1.5N NH_4F at pH 8. (auth)

ZIRCONIUM - Ion Exchange 2.53.01

2354 NYOO-1451
Ionics, Inc., Cambridge, Mass.
PROGRESS REPORT FOR JULY 5, 1949 TO SEPTEMBER 26, 1949. Oct. 13, 1949. Changed from OFFICIAL USE ONLY Aug. 10, 1956. 49p. Contract AT(30-1)-665. $7.80(ph OTS); $3.30(mf OTS).

Preliminary work on anion-exchange separation of Zr–Hf mixtures indicate no significant separation by conventional eluting techniques. A separation of Zr and Hf by precipitation of hydroxide from fluozirconate solutions was obtained, and transfer of this process applying resin-precipitation elution techniques has been attempted. (auth)

ZIRCONIUM - Solvent Extraction 2.53.02

4188 ORNL-105
Oak Ridge National Lab., Tenn.
CHELATE PROCESS FOR ISOLATING ZIRCONIUM. Period Covered: December 1947 To April 1948. T. C. Runion. May 26, 1948. Decl. Jan. 6, 1956. 26p. Contract [W-7405-eng-26]. $4.80(ph OTS); $2.70(mf OTS).

A process is presented for the isolation of radioactive Zr from solutions of Pu, U, and fission products based on extraction with thenoyltrifluoroacetone (TTA) in benzene. (auth)

United Kingdom Atomic Energy Authority. Industrial Group. Windscale Works, Sellafield, Cumb., England.
NOTES ON ZIRCONIUM CHEMISTRY IN NITRIC ACID SOLUTION AND ITS EXTRACTION INTO T.B.P./O.K. D. Smithies. Apr. 13, 1956. 11p. (IGC-B205WP/P-1).

Previous work on the chemistry of zirconium in aqueous solution with reference to the species present and their extractability into TBP/OK is reviewed. A summary of methods that can be used to study equilibria in solution is also given. (auth)

ZIRCONIUM - Solvent Extraction 2.53.02

2470

ISOLATION OF ZIRCONIUM AND NIOBIUM FROM FISSION PRODUCTS BY SOLVENT EXTRACTION WITH DILUTE TBP. T. Ishimori, H. Umesawa, and K. Watanabe (Japan Atomic Energy Research Inst., Tokyo). J. Atomic Energy Soc. Japan 1, 299-303(1959). (In Japanese)

Extraction with 1% TBP in toluene from 8 to 10 N hydrochloric acid provides a method for the separation of zirconium and niobium from the slow neutron fission products of uranium. A synthetic mixture was prepared by adding $Zr^{95}-Nb^{95}$ into an old fission products solution. From the mixture, $Zr^{95}-Nb^{95}$ was recovered by 1% TBP extraction from 10 N hydrochloric acid. The fission products of uranium, irradiated in JRR-1 for 2 hr and cooled for one day, were dissolved in 8 N hydrochloric acid and shaken with 1% TBP. The zirconium and niobium extracted were stripped from the organic phase with 0.5 N hydrochloric acid. Starting from a mixture of $Zr^{95}-Nb^{95}$, Ce^{141} and small amounts of other fission products, $Zr^{95}-Nb^{95}$ was isolated by a similar extraction from 10 N acid. (auth)

8366 ORNL-2498

Oak Ridge National Lab., Tenn.

THE USE OF TRI-n-OCTYLPHOSPHINE OXIDE IN THE SOLVENT EXTRACTION OF ZIRCONIUM. J. C. White and W. J. Ross. Apr. 24, 1958. 38p. Contract W-7405-eng-26. $1.25(OTS).

Zirconium is extracted readily by tri-n-octylphosphine oxide (TOPO) from acidic chloride and nitrate solutions, to a lesser extent from perchlorate, but only slightly from sulfate or fluoride media. Complete extraction of zirconium from sulfate, fluoride, and tartrate solutions can be achieved with multiple equilibrations when chloride or nitrate ions, especially as $AlCl_3$ or $Al(NO_3)_3$, are added to the aqueous solutions. In chloride and nitrate systems, the extraction coefficient increases from < 10 in 1 M acids to > 1000 in 7 M HCl or HNO_3. Similar enhancement is obtained by the addition of chloride or nitrate as the salts of mono-, di-, or trivalent metals. Extraction coefficients, > 100, are achieved in 1 M acid systems that also are > 3 M with respect to chloride or nitrate. The amount of zirconium that can be extracted to > 99% in a single, 10-min. equilibration period is 40 mg from chloride and 30 mg from nitrate solution per millimole of TOPO. The efficiency of the extraction is not impaired when the aqueous to organic phase ratio is varied between 1 and 20. The extracted species are $ZrCl_4 \cdot 2[n-(C_8H_{17})_3PO]$ and $Zr(NO_3)_4 \cdot 2[n-(C_8H_{17})_3PO]$, respectively. (auth)

TAIL END TREATMENT FOR ZIRCONIUM-NIOBIUM REMOVAL. F. R. Bruce. May 1, 1957. p. 277-85 of SYMPOSIUM ON THE REPROCESSING OF IRRADIATED FUELS HELD AT BRUSSELS, BELGIUM, MAY 20-5, 1957. 1165p. (TID-7534(Bks. 1-3))

Zr and Nb are two of the most troublesome fission products associated with U recovered by the TBP process. It has been found that both of these elements are removed by passage of the U product solution through a silica gel bed. Valid experimentation on silica gel removal of Zr and Nb may be conducted only with solutions typical of the process solutions anticipated. Accordingly, the activity level in the feeds studied has been very low, and it is difficult to obtain consistent and accurate measurements of the effectiveness of the adsorption step. For this reason, much of the data are significant only in that they indicate trends. 6 references.

Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Augusta, Ga.

ANOMALOUS EXTRACTION OF ZIRCONIUM, NIOBIUM, AND RUTHENIUM BY TRIBUTYL PHOSPHATE. Richard M. Wallace and Henry Pollock. Sept. 1958. 25p. Contract AT(07-2)-1. $0.75(OTS).

The abnormally high extraction of Zr, Nb, and Ru by 30% tributyl phosphate, even when nearly saturated with uranyl nitrate, is attributed to the presence of an organophilic carrier that is present in the initial HNO_3 solutions of irradiated U. The carrier remains in the organic phase making the desorption of these fission products from the organic phase a very slow process. Some evidence indicated that the carrier may be hydrated silica. Extraction of Zr, Nb, and Ru by TBP was reduced greatly by adding macroamounts of Nb compounds to the feed and precipitating Nb_2O_5 prior to solvent extraction. (auth)

ZIRCONIUM - Solvent Extraction 2.53.02

7583
SOLVENT EXTRACTION OF ZIRCONIUM WITH TRIBUTYL PHOSPHATE. Arnold E. Levitt and Harry Freund. Cornwallis. (University of Massachusetts, Amherst, and Oregon State College). J. Am. Chem. Soc. 78, 1545-9(1956) Apr. 5.

A study of the effect of certain variables on the extraction of Zr from HCl solutions by tributyl phosphate (TBP) has been made. The variation in the Zr distribution ratio D with TBP concentration in TBP–benzene solutions gives evidence of a 2:1 molar ratio of TBP to Zr in the species extracted. Studies were made of the Cl:Zr molar ratio in the organic phase. An investigation of the variation of D with aqueous chloride concentration at constant acidity and constant ionic strength was made. The effect of aqueous acidity on D at constant chloride concentration and constant ionic strength was also investigated. The results of these studies offer evidence for $ZrCl_4(TBP)_2$ as the species present in the organic phase. A decrease in D with increasing initial zirconium concentration at constant aqueous HCl concentration and constant organic TBP concentration indicates greater extent of Zr polymerization in the aqueous phase than in the organic phase. (auth)

9216
SEPARATION OF ZIRCONIUM FROM OTHER ELEMENTS BY LIQUID-LIQUID EXTRACTION. F. L. Moore (Oak Ridge National Lab., Tenn.). Anal. Chem. 28, 997-1001(1956) June.

The extraction behavior of Zr at both tracer and macro concentrations from aqueous solutions of HNO_3, HCl, and $H_2C_2O_4$ into 0.5M 2-thenoyltrifluoroacetone–xylene is described, as well as the separation of Zr from other elements. Peroxy complexing of Nb and Pa is particularly effective in achieving clean separations of these elements from Zr. Several general applications of this liquid-liquid extraction technique to problems involving the purification of radio Zr, the removal of radio Zr when present as an interference, the rapid determination of radio Zr in radioisotope and fission product solutions, and the separation of inactive Zr from interferences prior to its determination are discussed. (auth)

53 BLG-20
Brussels. Centre D'Étude de l'Énergie Nucléaire. STUDIE AANGAANDE DE CHEMISCHE ZUIVERING EN DE SCHEIDING VAN Zr/Hf MENGSELS (DEEL II) DE SCHEIDING VAN Zr/Hf MENGSELS. (Study Concerning the Chemical Purification and the Separation of Zr–Hf Mixtures. Part II. The Separation of Zr–Hf Mixtures. N. Issac and R. DeWitte. Mar. 15, 1958. 20p.

Two well-known separation methods were studied with three different liquid-liquid extraction columns to determine the possibility of using them for Zr production. A small quantity of nuclear pure ZrO_2 was produced from a product containing 2.5 to 3% HfO_2. It was proposed that a pilot-plant study be made of the H. C. Peterson-G. H. Beyer method for the separation of Zr and Hf. (tr-auth)

ZIRCONIUM - Other 2.53.03

265
THE SEPARATION OF TANTALUM, NIOBIUM AND ZIRCONIUM BY FRACTIONAL DISTILLATION. L. A. Nisel'son. Nauch. Doklady Vysshei Shkoly Met. No. 3, 285(1958).

A rapid separation and purification of tantalum and niobium is carried out by the interaction of the pentachlorides with phosphorus oxychloride. The metal sample investigated, which had the composition 22.5% Nb, 59% Ta, and 18% Zr, was converted into chlorides and then was treated with phosphorus oxychloride. The following fractions were obtained: (1) Niobium fraction with about 86% Nb and 0.1% Ta. (2) Tantalum fraction with about 81% Ta and 0.015% Nb. Zirconium was not found in these fractions. The intermediate fractions contain tantalum, niobium, and zirconium and may be subjected to the fractional distillation another time. The method of the fractional distillation of pentachlorides in the presence of phosphorus oxychloride has some advantages as compared to the fractional distantalum. The reaction products of niobium and tantalum with phosphorus oxychloride are characterized by a higher volatility than the pentachlorides, and they also show a greater difference between boiling and melting temperatures. (TCO)

ZIRCONIUM - Other 2.53.03

Horizons, Inc., Cleveland.
THE EXTRACTIVE METALLURGY OF ZIRCONIUM BY THE ELECTROLYSIS OF FUSED SALT; FINAL REPORT. Morris A. Steinberg, Merle E. Sibert, Bertram C. Raynes, and Eugene Wainer. Feb. 15, 1953. 203p. (NYO-3121).
The bibliography found in this report consists of 67 references to published, patent, and report literature.

2501 COO-106
Graham, Crowley, and Associates, Inc., Jenkintown, Penna.
ELECTRODEPOSITION OF ZIRCONIUM. Progress Report No. 2 Covering Period February 1, 1952 to April 30, 1952. Changed from OFFICIAL USE ONLY June 22, 1956. 47p. Project No. J-132. Contract AT(11-1)-173. $7.80(ph OTS); $3.30(mf OTS).
Zirconium tetrachloride has been found to be appreciably soluble in acetonitrile and dimethyl formamide to form solutions which are conductive. These have been electrolyzed at current densities of 1, 5 and 10 amp./sq.dm. with platinum cathodes. The acetonitrile solutions were also electrolyzed with zirconium and mercury cathodes. No metallic deposits of zirconium were obtained. However, zirconium metal was found to function as a soluble anode in both of these electrolytes. The possible formation of an ionized complex of zirconium tetrachloride and lithium hydride or lithium aluminum hydride in ethyl ether was investigated. Similar studies are planned using tetrahydrofuran in the place of ethyl ether. (auth)

2490 AECD-3743
Massachusetts Inst. of Tech., Oak Ridge, Tenn. Engineering Practice School.
ZIRCONIUM PURIFICATION PILOT PLANT. D. C. Lea, A. A. Aykanian, R. F. Abbanat, and W. H. Bowman. Sept. 12, 1950. Decl. June 28, 1956. 34p. For Carbide and Carbon Chemicals Div. [K-25 Plant. Contract W-7405-eng-26, Subcontract 70]. (KT-89). $6.30(ph OTS); $3.00(mf OTS).
The operation and operating conditions of a Zr purification pilot plant are discussed. (J.H.M.)

2512 NYO-1025
Horizons Inc., Cleveland.
THE PRODUCTION OF ZIRCONIUM BY FUSED SALT ELECTROLYSIS. M. A. Steinberg. Oct. 26, 1949. Changed from OFFICIAL USE ONLY Aug. 16, 1956. 114p. Contract AT(30-1)-696. $18.30(ph OTS); $6.00(mf OTS).
An investigation of the production of Zr by electrolysis of fused salt baths containing halides and double halides of Zr is presented. Data are included on electrolysis of Zr from aqueous and non-aqueous solutions at room temperature, experimental equipment, use of a vitrified Zr porcelain crucible, anode graphite rods and Mo, Ni, nichrome, and Cu cathodes, production of amorphous Zr powder, and thermochemical data on cell reaction. A literature survey containing 62 references ~~are~~ included. ~~(W.L.H.)~~

1288 CC-2009
Clinton Labs., Oak Ridge, Tenn.
PREPARATION OF CARRIER FREE Zr–Cb TRACER. Progress Report on Problem Assignment 263-X61C. J. A. Marinsky and N. E. Ballou. Aug. 28, 1944. Decl. Nov. 28, 1955. 5p. (A-2870)
The cupferron–chloroform method for the preparation of carrier-free Zr and Cb activities has been shown to be quite specific. A preparation which is better than 99.8 to 99.9% pure is readily obtained and the time required is about 1.5 hours. The technique is simple and small laboratory preparations are very easily and quickly performed; good adaptability to remote control is indicated. (auth)

ZIRCONIUM - Other 2.53.03

1809

REDUCTION OF METAL CHLORIDES. (to St. Joseph Lead Co. (U.S.A.)). British Patent 776,124. Nuclear Eng. 2, 452(1957) Oct.

Reduction of chlorides of titanium and zirconium using a steam of molten magnesium chloride in continuous circulation forming an upward and a downward current between an upper and a lower body of the chloride is reported. Molten magnesium and titanium tetrachloride or zirconium tetrachloride are introduced in certain proportions into the lower portion of the upwardly inclined current. From the lower body a suspension of titanium or zirconium in magnesium chloride is withdrawn. (auth)

FLOATING ZONE PURIFICATION OF ZIRCONIUM. G. D. Kneip, Jr., and J. O. Betterton, Jr., (Oak Ridge National Lab., Tenn.). J. Electrochem. Soc. 103, 684-9(1956) Dec.

The Fe and Ni contents of iodide Zr have been reduced to less than 2 ppm by the floating zone refining technique. The α/β transformation takes place over a temperature interval of 865 to 873°C in the purified material instead of the 16 to 70°C intervals found in grade 1 crystal bar. Fe and Ni distributions after multiple pass refining have been established by neutron activation analyses and the values agree with those calculated by the theory. (auth)

312 ISC-720

Ames Lab., Ames, Iowa.

PREPARATION OF ZIRCONIUM FROM ZIRCONIUM TETRAFLUORIDE. C. J. Baroch and G. H. Beyer. May 31, 1956. 18p. Contract W-7405-eng-82. $0.20(OTS).

Experimental bomb reductions of ZrF_4 with Mg were carried out. A charge of 350 g of ZrF_4, 105 g of ZnF_2, and 142 g of Mg gave good metal recovery and good metal-slag separation. Reaction of the ZnF_2 with Mg furnished the additional heat needed to melt the slag. The Zn–Zr alloy formed melted at about 1000°C, while the MgF_2 slag melted at about 1250°C. After dezincing, the Zr sponge was melted and its hardness measured. Hardness values of 62 on the Rockwell A Scale indicated the probable presence of impurities. With more stringent control of the purity of the reactants and by the use of larger bombs, it should be possible to produce higher purity Zr by this method. (auth)

6682 NP-6276

Brussels. Centre D'Etudes Pour Les Applications de l'Energie Nucleaire.

ETUDE SUR LA PURIFICATION DU MELANGE (Zr–Hf) ET SUR LA SEPARATION (Zr–Hf). PART I. PURIFICATION DU MELANGE (Zr–Hf). (Study on the Purification of the Zr–Hf Mixture and on Zr–Hf Separation. Part I. Purification of the Zr–Hf Mixture). N. Isaac and R. De Witte. Sept. 13, 1955. 28p. (B-1).

An experimental study was made of the processes of the corrosion of the oxide and of the purification of the salts of Zr cited in the literature. Starting with technical oxide containing 3% Hf and other impurities, the following method was set up: treatment of the oxide by hot concentrated HCl to extract Fe, Al, and Cr; dissolution of the oxide in 80% boiling H_2SO_4 and separation of the silica; purification of the sulfate by crystallization of its HCl–H_2SO_4 solution; neutralizations by NH_4OH and dissolutions in 20% HCl repeated until the absence of SO_4^{2-} ions; purification of the oxychloride by crystallization of its hydrochloric solution. (tr-auth)

2505 COO-180

Graham, Crowley and Associates, Inc., Jenkintown, Penna.

ELECTRODEPOSITION OF ZIRCONIUM. Progress Report No. 6 Covering Period February 1, 1953 to April 15, 1953. Changed from OFFICIAL USE ONLY June 22, 1956. 26p. Project J-132. Contract AT(11-1)-173. $4.80(ph OTS); $2.70(mf OTS).

Conductivity studies were carried out in a number of non-aqueous systems with a view of finding conductive Zr complexes from which the metal could be electrodeposited. Conductive complexes were found to form in the following three systems: zirconium tetraiodide–nitrobenzene, zirconium tetraiodide–acetonitrile, and zirconium tetrachloride–pyridine. The latter two of these systems were electrolyzed. In both instances, weighable cathode deposits were obtained which upon analysis were found to contain Zr in a non-metallic form. Two additional non-aqueous systems which had been found to be conductive in previous work, were also electrolyzed. These were the systems, zirconium tetrachloride–boron trifluoride–ethyl ether and zirconium tetrachloride–ferric chloride–nitrobenzene. Again in both electrolyses, weighable cathode deposits were obtained which upon analysis proved to contain Zr in a non-metallic form. (auth)

ZIRCONIUM - Other 2.53.03

22052

SEPARATION PROCESS FOR ZIRCONIUM AND COMPOUNDS THEREOF. H. W. Crandall and J. R. Thomas (to U. S. Atomic Energy Commission). U. S. Patent 2,892,681. June 30, 1959.

The separation of zirconium from columbium, rare earths, yttrium and the alkaline earth metals, such mixtures of elements occurring in zirconium ores or neutron irradiated uranium is described. According to the invention a suitable separation of zirconium from a one normal acidic aqueous solution containing salts, nitrates for example, of tetravalent zirconium, pentavalent columbium, yttrium, rare earths in the trivalent state and alkaline earths can be obtained by contacting the aqueous solution with a fluorinated beta diketone alone or in an organic solvent solution, such as benzene, to form a zirconium chelate compound. When the organic solvent is present the zirconium chelate compound is directly extracted; otherwise it is separated by filtration. The zirconium may be recovered from contacting the organic solvent solution containing the chelated compound by back extraction with either an aqueous hydrofluoric acid or an oxalic acid solution.

PROCESS FOR PURIFYING TITANIUM TETRAHALIDES OR ZIRCONIUM TETRAHALIDES. Raymond James Wigginton and Howard Arthur Stanley Bristow (to Laporte Titanium, Ltd.). British Patent 810,822. Mar. 25, 1959.

A fluidized bed process for purifying $ZrCl_4$ or $TiCl_4$ is presented. The halide vapor from the halogenation step is passed directly through a fluidized bed of metal or metal-coated particles where impurities such as V react with the metal. The fluidized bed may consist of Cu, Zn, Fe, Ni, Ca, Mg, Al, Ti, Pb, Sb, Sn, or Na particles. A three-zone process is described in which two zones are being fluidized and used while the third zone is being recharged with metal powder. (T.R.H.)

4577

PROCESS FOR REMOVING HAFNIUM FROM ZIRCONIUM-CONTAINING MATERIAL. I. E. Newnham (to Commonwealth Scientific and Industrial Research Organization). British Patent 780,477. Nuclear Eng. 3, 42(1958) Jan.

The zirconium compounds and the associated hafnium compounds are converted into tetrahalides. The zirconium tetrahalide is reduced to one or more lower halides or even to metallic zirconium, while the hafnium tetrahalide remains unchanged. This and any unreduced zirconium tetrahalide is then separated from the zirconium reduction product.

ON THE IODIDE METHOD OF PURIFYING ZIRCONIUM. K. D. Sinelnikov, F. I. Busol, and G. I. Stepanova. Atomnaya Energiya 4, 169-74(1958). (In Russian)

The equilibrium constants k and k′ in the reactions $Zr + 2I_2 - ZrI_4 = 0$ and $2I - I_2 = 0$ have been determined by a method based on the measurements of recovered iodide and zirconium from zirconium tetraiodide decomposition on the heated surface during the equilibration process. The decomposition of tetraiodide takes place on the tungsten filament at 900 to 1600°C. The temperature distribution between the filament and the container walls was not considered. The relation of the total of the atomic and molecular iodide pressure $P_I + P_{I_2}$ to the zirconium tetraiodide pressure at 1430°C and on the temperature with $P_{ZrI_4} \approx 50$ mm of mercury is given. (tr-auth)

14818 A/CONF.15/P/698

Bureau of Mines. Electrometallurgical Experiment Station, Boulder City, Nev.

ELECTROREFINING OF VANADIUM, CHROMIUM, ZIRCONIUM, AND HAFNIUM. D. D. Blue and D. H. Baker, Jr. 17p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

The inert-gas-shielded, molten-salt, electrorefining technique has proved adaptable to improving the quality of a number of metals, in addition to those discussed. The basic method is very promising for refining a number of metals that have resisted purification by established techniques. The selection of electrolytes and operating variables has to date been arbitrary and empirical, in many instances. The theory and chemistry of the process are as yet vague and little understood. Although there is nothing inherently expensive in the electrorefining procedure, mechanical improvements will undoubtedly permit easier operation and less drastic controls. The method offers a challenging field of research for developing sampling and analytical techniques, evolving chemistry to permit theoretical selection of promising and workable electrolytes, and devising of mechanical innovations permitting continuous, less exacting operation. (auth)

See also, under FISSIONABLE MATERIAL—RECOVERY, RECOVERY OF PLUTONIUM (3.03).

TRANSURANICS - SEPARATION OF Americium 2.54.01

See also, under PROCESS CHEMISTRY AND ENGINEERING, SPECIAL PROCESSES--Americium Recovery (6.17.01).

2483

SEPARATION OF AMERICIUM FROM PROMETHIUM. R. E. Pressly (to U. S. Atomic Energy Commission). U. S. Patent 2,893,827. July 7, 1959.

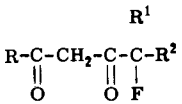
Promethium-147 is separated from americium in acidic aqueous solution by adding fluosilicic acid to the solution, heating the solution to form a promethium precipitate and separating the precipitate from solution. The precipitate is then re-dissolved by the addition of boric acid and nitric acid, and re-precipitated by the addition of fluosilicic acid. This procedure is repeated six or more times to obtain a relatively americium-free promethium precipitate. Americium may be separately recovered from the supernatant liquids. This process is applicable to the recovery of promethium from fission-product solutions which have been allowed to decay for a period of two to four years.

TRANSURANICS - SEPARATION OF Americium 2.54.01

2487

SEPARATION PROCESS FOR ACTINIDE ELEMENTS AND COMPOUNDS THEREOF. L. B. Werner, I. Perlman, and M. Calvin (to U. S. Atomic Energy Commission). U. S. Patent 2,894,805. July 14, 1959.

This patent deals with the separation of americium and/or curium salts from lanthanum salt contained in an aqueous solution by contacting the latter, after adjustment of the pH to between 2 and 4.8, with an organic water-immiscible solution of a fluorinated β-diketone of the formula



wherein R is an alkyl, aryl, aralkyl, alkaryl or heterocyclic radical and R^1 and R^2 are hydrogen or fluorine; the americium and/or curium salt is selectively extracted as a chelate with the β-diketone. Americium and/or curium salt can also be separated by the same method from thorium salt contained in an aqueous solution, provided that the pH value is between 0.2 and 3; the thorium is chelated and extracted away from americium and curium.

13805

CO-PRECIPITATION OF LANTHANUM, CERIUM AND AMERICIUM WITH POTASSIUM SULFATE. V. I. Grebenshchikova and V. N. Bobrova. Zhur. Neorg. Khim. 3, 40-5(1958). (In Russian)

In the coprecipitation of La, Ce, and Am with K_2SO_4, it was shown that the ions not only coprecipitated but that they also are adsorbed by crystalline deposits. Therefore, adsorption and crystallization were investigated separately. The specific surface of the adsorbent was calculated, and it was found that the quantity adsorbed increases with the concentration of the elements in the solution. The adsorption is not affected by the presence of foreign ions. From the study of the cocrystallization it appears that La, Ce, and Am are carried in the interior of the potassium sulfate crystal and distributed there. It is concluded that these elements form anomalous mixed crystals not having a lower boundary of miscibility. (J.S.R.)

TRANSURANICS - SEPARATION OF
Americium 2.54.01

ION EXCHANGE BEHAVIOUR AND DISSOCIATION CONSTANTS OF AMERICIUM, CURIUM, AND CALIFORNIUM COMPLEXES WITH ETHYLENEDIAMINETETRA-ACETIC ACID. J. Fuger (Univ. of California, Berkeley). J. Inorg. & Nuclear Chem. 5, 332-8(1958).

Separation factors between californium, curium, and americium on ion exchange resin Dowex-50 X-12, in ammonium form, have been calculated from static equilibrations between pH 2 and pH 3.3 in presence of EDTA 10^{-7} M. They are found to be 2.04 ± 0.05 between americium and curium and 5.5 ± 0.1 between curium and californium. In the experimental conditions, only 1 : 1 complexes are formed, and by ion exchange techniques, the dissociation constants are found to be equal to: californium: $10^{-19.09\pm0.2}$; curium: $10^{-18.45\pm0.1}$; americium: $10^{-18.16\pm0.1}$. Preliminary column experiments show that this complexing agent will be quite useful for separating actinide elements. (auth)

9259

ION EXCHANGE SEPARATION OF GRAM QUANTITIES OF AMERICIUM FROM A KILOGRAM OF LANTHANUM. D. E. Armstrong, L. B. Asprey, J. S. Coleman, T. K. Keenan, L. E. LaMar, and R. A. Penneman (Los Alamos Scientific Lab., N. Mex.). A.I.Ch.E. Journal 3, 286-8(1957) June.

The separation of 4.5 g. of Am from ~1 kg of light rare earths (primarily La) was achieved on a pilot plant scale by chromatographic displacement of the mixture from Dowex-50 resin with 0.1% ammonium citrate at pH 8 into hydrogen-form Dowex-50. The Am collected into a narrow band and was eluted free from La but contained an equal weight of Ce. A 6- and a 2-in.-diam. column were used in tandem. Use of a final column with a much smaller diameter would have permitted a cleaner separation from Ce, but this was left for a laboratory-scale separation by a different process. Precipitation, which was observed in the columns during the first runs, was later avoided entirely by use of high flow rates both initially and during the transfer between columns. No adverse effects were noted from ~15 curies of alpha activity. (auth)

1004

SEPARATION OF ACTINIDE ELEMENTS BY CATION EXCHANGE USING ALPHA-HYDROXY ISOBUTYRIC ACID. J. Milsted and A. B. Beadle (Atomic Energy Research Establishment, Harwell, Berks, England). J. Inorg. and Nuclear Chem. 3, 248(1956) Oct.

The separation factors for Am, Cf, and Cm by elution from Zeo-Karb 225 resin with α-hydroxy isobutyric acid are determined. (T.R.H.)

11116

NONMONOTONIC ORDERING OF LANTHANIDES IN TRIBUTYL PHOSPHATE-NITRIC ACID EXTRACTION SYSTEMS. D. F. Peppard, W. J. Driscoll, R. J. Sironen, and S. McCarty (Argonne National Lab., Lemont, Ill.). J. Inorg. and Nuclear Chem. 4, 326-33(1957).

The partition of tracer-level lanthanides, Y, and Am between various TBP phases and aqueous HNO_3 phases has been studied radiometrically as a function of solvent concentration, HNO_3 concentration, and Z. In undiluted TBP systems, a plot of log K vs. Z approximates two straight lines joining at Z = 64. The line for the high-Z region has a positive slope somewhat less than that of the line for the low-Z region at 18.5 M HNO_3. This difference in slope becomes intensified as the concentration of HNO_3 is lowered, the high-Z line ultimately acquiring a negative slope. The slope of the low-Z line remains positive throughout the region studied. This general half-filled shell effect is also noted for systems involving diluted TBP. It is postulated that the extracting species is $[M(TBP)_a(H_2O)_{(x-a)}](NO_3)_3$, in which a is a function of the HNO_3 concentration and of Z. In all of the systems studied, for plotting purposes Y may be assigned an "apparent Z" of 65 to 68. In the dilute HNO_3 systems, the Am plot is nearly coincident with that for praseodymium. (auth)

Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.

A BATCH PROCESS FOR THE RECOVERY OF Am^{241} FROM KILOGRAM AMOUNTS OF PLUTONIUM. J. P. Butler and J. S. Merritt. Aug. 1956. 28p. (AECL-353).

By precipitating PuO_4 from Pu solutions 1 to 2N in acid, the Am associated with the Pu can be recovered in the supernatant in about 98% yield. This procedure has been carried out with 100 to 200 g. batches of Pu. The method has the advantage that Pu is readily recovered in 99.8% yield, in a very small volume. It has the further advantage that the Pu is decontaminated from most cations so that, besides being a process for the recovery of Am, it can also be used as a final step in the purification of Pu. From 2.03 kg of plutonium processed, 0.8 g of Am^{241} have been recovered. The Am has been purified from Pu and other cations by standard precipitations and by the use of anion and cation exchange resins. The yield of Am through the purification was 98.4%. In all 770 mg of Am^{241} with a Pu content of 0.02 ppm were recovered. Spectrographic analysis of the final product showed no detectable impurities. (auth)

TRANSURANICS -SEPARATION OF
Americium 2 54.01

769 DP-173
Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Augusta, Ga.
THE PREPARATION OF AN AMERICIUM GAMMA SOURCE. Robert C. Milham. Aug. 1956. 10p. Contract AT(07-2)-1. $0.15(OTS).

Americium^{241} was separated from La, Pu, and common metallic elements by ion exchange methods. The purified Am was embedded in plastic and mounted in a holder for use as a γ ray source. (auth)

2826 LA-2013
Los Alamos Scientific Lab., N. Mex.
COPRECIPITATION OF Am(III) WITH LANTHANUM OXALATE. John A. Hermann. Mar. 1956. 98p. Contract W-7405-eng-36. $2.75(OTS).

This report supersedes AECD-3637 (LAMS-1625).

The coprecipitation of americium with $La_2(C_2O_4)_3 \cdot 11H_2O$ is investigated. The separation and purification of americium from lanthanum and other cationic impurities by fractional precipitation of lanthanum oxalate is demonstrated. Fractions of the lanthanum oxalate carrier were precipitated from homogeneous solutions by the hydrolysis of dimethyl oxalate in dilute nitric acid solutions. Ameri- shown to vary with the rate of precipitation of lanthanum oxalate, decreasing as the rate of precipitation increases. A theory for the effect of rate of precipitation on coprecipitation is presented, based on the qualitative relationship between rate of precipitation and supersaturation. An equation relating the observed distribution coefficient with the supersaturation, and thus indirectly with the rate of precipitation, is derived. The application of the supersaturation concept to published data on coprecipitation and to occlusion of impurities by analytical precipitates is discussed. It is suggested that many carrying phenomena of ionic precipitates which have been explained qualitatively by occlusion can be explained quantitatively by relating coprecipitation to supersaturation. A new method of measuring the heterogeneous distribution coefficient is presented. The method depends upon achieving experimental conditions such that the carrier precipitate is brought down from a saturated solution of constant carrier concentration. Under these conditions the heterogeneous distribution coefficient, λ, is determined experimentally in accordance with the equation

$$\log_e \frac{\text{total tracer}}{\text{tracer left in solution}} = \lambda \frac{\text{weight of carrier precipitated}}{\text{weight of carrier in solution}}.$$

For the americium-lanthanum oxalate coprecipitation system the distribution coefficient was found to be 6.5 ± 0.1. The method has possible industrial application in the field of radioactive-waste decontamination. A high "carrying" efficiency requires not that the distribution coefficient be high but that the ratio of the distribution coefficient to the carrier solubility be high. (auth)

4566 LA-1975
Los Alamos Scientific Lab., N. Mex.
PURIFICATION OF GRAM AMOUNTS OF AMERICIUM. J. S. Coleman, D. E. Armstrong, L. B. Asprey, T. K. Keenan, L. E. LaMar, and R. A. Penneman. Nov. 1955. 39p. Contract W-7405-eng-36. $6.30(ph OTS); $3.00 (mf OTS).

Methods of Am purification are discussed under three classifications: ion exchange, solvent extraction, and precipitation. Two new ion-exchanger processes for the separation of Am from rare earths are described in detail. The first involves absorption of rare earths and Am on a column of hydrogen-form cation exchanger, followed by elution with 0.1% ammonium citrate, pH 8 · ne second utilizes the marked tendency of strongly basic anion exchangers to absorb Am in preference to the rare earths from ammonium thiocyanate solutions. Solvent extraction with TBP is recommended for gross decontamination of Am crudes, and oxidation-reduction cycles suitable for final purification of Am concentrates are outlined. (auth)

2042 ANL-5361
Argonne National Lab., Lemont, Ill.
PRODUCTION OF Pu^{246} IN THE MTR. Herbert Diamond and Raymond F. Barnes. Nov. 1954. Decl. Sept. 23, 1955. 6p. Contract W-31-109-eng-38.

Pu^{246} and its β^- decay product, Am^{246}, have been detected in a Pu–Al alloy irradiated in the core of the materials testing Reactor for 600 days. The separation of Pu^{246} from fission products and of Am^{246} from Pu^{246} is described. The half lives of the isotopes were measured and were in good agreement with previously reported values. The MTR neutron capture cross section for formation of Pu^{246} from Pu^{245} was measured as 260 ± 145 barns. (M.P.G.)

TRANSURANICS - SEPARATION OF
Americium 2.54.01

1885 LA-1861
Los Alamos Scientific Lab., N. Mex.
EXTRACTION OF AMERICIUM NITRATE WITH TRIBUTYL PHOSPHATE. K. A. Walsh. Jan. 4, 1955. Decl. Apr. 1, 1957. 31p. Contract W-7405-eng-36. $0.35(OTS).

The extraction of $Am(NO_3)_3$ with TBP has been investigated for aqueous solutions containing $NaNO_3$ and HNO_3. $Am(NO_3)_3$ is found in the organic phase as free molecules or ions and as the complex $Am(NO_3)_3 \cdot 3TBP$. Aqueous solutions containing HNO_3 introduce a competitive factor through the formation of a $TBP \cdot HNO_3$ complex in the solvent layer. In addition, $Am(NO_3)_3$ is complexed in the aqueous phase by HNO_3 as $HAm(NO_3)_4$. The equilibrium expressions for the prevailing reactions in the solvent extraction process have been combined to give the extraction coefficient,

$$\Sigma_a^o = \frac{\Sigma Am, org}{\Sigma Am, aq} = \frac{0.0109(NO_3^-)^3 + 0.00653(NO_3^-)^3 (TBP)^3}{1 + 0.038 [H^+][NO_3^-]^4}$$

The constants were evaluated for systems containing 1M to 5M $NaNO_3$ and 2M to 5M HNO_3 so that the activity coefficient of $Am(NO_3)_3$ remained nearly constant. (auth)

2269 LA-1699
Los Alamos Scientific Lab., N. Mex.
PLANT-SCALE CONCENTRATION OF Am AND Pu III USING TRIBUTYL PHOSPHATE. W. J. Maraman, A. J. Beaumont, R. S. Day, and R. S. Winchester. Aug. 2, 1954. Decl. Nov. 6, 1957. 13p. Contract W-7405-eng-36. $3.30(ph OTS); $2.40(mf OTS).

Am^{3+} and Pu^{3+} have been recovered on a plant scale by extraction with tributyl phosphate from slag and crucible and other recovery solutions. Process losses were 0.03% Am and 0.01% Pu. The product stream contained 0.08 gram Am per liter and 0.15 gram Pu per liter. The final solution cleanup to allow discard (total alpha activity equivalent to less than 10^{-4} gram Pu per liter) was accomplished by tributyl phosphate extraction of Pu^{3+} under conditions of low acidity and high nitrate. (auth)

Transuranic Elements and Compounds

1907 LA-1079(Del.)
Los Alamos Scientific Lab., N. Mex.
QUANTITATIVE SEPARATION OF AMERICIUM AND PLUTONIUM USING CUPFERRON. J. P. Nigon and R. A. Penneman. Mar. 8, 1950. Decl. with deletions Feb. 7, 1957. 10p. Contract W-7405-Eng-36. $1.80(ph OTS); $1.80(mf OTS).

Americium and Pu are separated quantitatively by chloroform extraction of Pu cupferrate from HCl solution. This separation is successful from tracer concentrations up to gram quantities of Pu, and milligrams of Am. The separation is made routinely at two widely different Am/Pu ratios: (1) during Am purification where the Am/Pu ratio is of the order of 1/10; and (2) for Am assays on Pu solutions where the Am/Pu ratio varies from 10 to 250

TRANSURANICS - SEPARATION OF
Berkelium 2.54.02

11137
ISOLATION OF BERKELIUM BY SOLVENT EXTRACTION OF THE TETRAVALENT SPECIES. D. F. Peppard, S. W. Moline, and G. W. Mason (Argonne National Lab., Lemont, Ill.). J. Inorg. and Nuclear Chem. 4, 344-8(1957).

Data for the extraction of Cm(III), Bk(III), and Bk(IV) into a n-heptane solution of di(2-ethyl hexyl) orthophosphoric acid from various aqueous nitric acid phases are presented. The K value for Bk(IV) is greater than that for Bk(III) or Cm(III) by a factor approaching 10^6. Under the oxidizing conditions used, Am remains in the trivalent state. A flow sheet utilizing this solvent extraction system and involving both the trivalent and tetravalent states of Bk has been devised. Using a raw berkelium fraction, isolated in the preliminary processing of an exhaustively neutron-irradiated plutonium sample, as feed, a Bk^{249} product was isolated in approximately 97% yield with established alpha decontami-

PROCESS OF PRODUCING Cm^{244} AND Cm^{245}. W. M. Manning, M. H. Studier, H. Diamond, and P. R. Fields (to U. S. Atomic Energy Commission). U. S. Patent 2,859,095. Nov. 4, 1958.

A process is presented for producing Cm^{244} and Cm^{245}. The first step of the process consists in subjecting Pu^{239} to a high neutron flux and subsequently dissolving the irradiated material in HCl. The plutonium is then oxidized to at least the tetravalent state and the solution is contacted with an anion exchange resin, causing the plutonium values to be absorbed while the fission products and transplutonium elements remain in the effluent solution. The effluent solution is then contacted with a cation exchange resin causing the transplutonium values to be absorbed while the fission products remain in solution. The cation exchange resin is then contacted with an aqueous citrate solution and the transplutonium elements are thereby differentially eluted in order of decreasing atomic weight, allowing collection of the desired fractions.

22143

LARGE SCALE METHOD FOR THE PRODUCTION AND PURIFICATION OF CURIUM. Gary H. Higgins and William W. T. Crane (to U. S. Atomic Energy Commission). U. S. Patent 2,887,358. May 19, 1959.

A large-scale process for production and purification of Cm^{242} is described. Aluminum slugs containing Am^{241} are irradiated and declad in a $NaOH-NaNO_3$ solution at 85 to 100°C. The resulting slurry filtered and washed with NaOH, NH_4OH, and H_2O. Recovery of Cm from filtrate and washings is effected by an $Fe(OH)_3$ precipitation. The precipitates are then combined and dissolved in HCl and refractory oxides centrifuged out. These oxides are then fused with Na_2CO_3 and dissolved in HCl. The solution is evaporated and LiCl solution added. The Cm, rare earths, and anionic impurities are adsorbed on a strong-base anion exchange resin. Impurities are eluted with LiCl–HCl solution, rare earths and Cm are eluted by HCl. Other ion exchange steps further purify the Cm. The Cm is then precipitated as fluoride and used in this form or further purified and processed. (T.R.H.)

8082

PRODUCTION OF CURIUM 243. S. G. Thompson, B. B. Cunningham, and A. Ghiorso (to U. S. Atomic Energy Commission). U. S. Patent No. 2,741,627, Apr. 10, 1956.

Curium isotopes Cm^{243} may be produced by bombarding $Am_2^{241}O_3$ with a 40 Mev beam of α particles in a cyclotron resulting in the formation of Cm^{243} as well as other elements constituting removable impurities. The bombarded target material is dissolved in HNO_3 and then treated with NH_3 to precipitate Am and Cm hydroxides. This precipitate is dissolved in K_2CO_3 and treated with NaOCl to remove the Am. The filtrate is treated with strong KOH to form a hydroxide precipitate of Cm and the remaining Am, which is retreated as above to reduce the Am content. Final purification from Am is made by adsorbing the Cm and remaining Am on a cation exchange resin and selectively eluting with ammonium citrate. (auth)

14710 A/CONF.15/P/1883

California. Univ., Livermore. Radiation Lab.
THE PRODUCTION AND CHEMICAL ISOLATION OF CURIUM^{242} IN THOUSAND-CURIE QUANTITIES. Gary H. Higgins and William W. T. Crane. 14p. (UCRL-5021). $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

An integrated system of process equipment and chemical separations was designed which would isolate gram quantities of curium while fulfilling four objectives: (1) that the curium be free of gross chemical and fission product impurities, (2) that the product yield would be high, (3) that personnel exposure would be low, and (4) that the process equipment would be replaceable and repairable during operation. The chemical process adopted consisted of combinations of ion exchange separations, thereby avoiding precipitation chemistry. The ion exchange columns were designed to accommodate the high radiation and thermal effects of the adsorbed

7157 CC-3625
Argonne National Lab., Lemont, Ill.
FRACTIONATION OF FISSION PRODUCTS AND HEAVY ELEMENTS BY VOLATILIZATION METHODS. N. D. Erway and O. C. Simpson. Aug. 27, 1946. Decl. Feb. 15, 1956. 45p. Contract W-31-109-eng-38. $7.80(ph OTS); $3.30(mf OTS).

A fractionating crucible having a number of collector plates was used to separate long-lived fission product oxides by volatilization methods. Collected activities were analyzed both by absorption measurements and by chemical separation. The degree of separation of Cm^{242} from Am^{241} was determined by pulse analysis of the alpha activities. It was possible to separate Am by this method using a spiral baffle system crucible and collecting the volatilizing activities on a single plate above the crucible orifice under certain optimum conditions. (F.S.)

TRANSURANICS - SEPARATION OF NEPTUNIUM 2.54.05

See also, under PROCESS CHEMISTRY AND ENGINEERING, SPECIAL PROCESSES--Neptex (6.17.16).

256 HW-61145(Del.)
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
RECOVERY OF PLUTONIUM AND NEPTUNIUM FROM PUREX IWW BY ANION EXCHANGE. H. H. Van Tuyl. July 16, 1959. Decl. with deletions Sept. 22, 1959. 6p. OTS.

The original purpose for installing the IWW anion exchange equipment in the Purex plant was to recover plutonium from high waste loss batches of IWW. The present work shows that this is feasible, and similar recovery of neptunium can also be obtained. The process can be applied to routine recovery of plutonium and neptunium from IWW even with only normal operating losses to the IWW, e.g., to reduce the neptunium losses currently experienced during reflux type operation. However, both technical and economic considerations would seem to indicate that recovery from batches with high plutonium or neptunium content would be more satisfactory. One attractive application is to recycle neptunium via the 3WB until a large inventory is developed, and then drop this to the IWW for anion exchange recovery. This has the distinct advantage of not requiring a plant shut-down for neptunium recovery. (auth)

ISOLATION OF NEPTUNIUM AS A MONO OCTYL PHOSPHORIC ACID COMPLEX BY LIQUID–LIQUID EXTRACTION. D. F. Peppard, G. W. Mason, and R. J. Sironen (Argonne National Lab., Lemont, Ill.). J. Inorg. & Nuclear Chem. 10, 117-27(1959) Apr.

The extraction of certain M(III), M(IV), and M(VI) actinides and lanthanides and Y(III) in the system mono(2-ethylhexyl) orthophosphoric acid (symbolized as H_2MEHP) in toluene diluent vs. aqueous HCl was investigated with respect to operational solvent and acid dependencies, state of oxidation, and Z, using the radioactive tracer technique. Through proper combination of solvent concentration and HCl concentration, systems may be devised by means of which M(IV) may be separated from M(VI) and M(III), or M(VI) may be separated from M(III). The ratio of the K values for Np(IV) and Np(VI) respectively exceeds 10^5 as does the ratio of the respective K values for U(IV) and U(VI). The ratio of the K value of Np(IV) to the K values of U(VI) and Pu(III) may be made greater than 10^4. A flow sheet for the isolation of Np as Np(IV) was devised and tested. This procedure requires only a single extraction with H_2MEHP (in toluene) followed by multiple scrubbing with 12 F HCl containing hydroquinone, or 6 F HCl containing hydroquinone and hydriodic acid, the reducing agents serving to reduce plutonium to Pu(III). The mechanism of extraction was examined tentatively in terms of ion exchange analogy and chloride complexing. The antisynergistic interaction of TBP (tri-n-butyl phosphate) with H_2MEHP was utilized in effecting the return of Np(IV) to an aqueous phase. (auth)

2469
DISTRIBUTION OF NEPTUNIUM BETWEEN TBP AND SOME MINERAL ACIDS. Tomitaro Ishimori and Eiko Nakamura (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan 32, 713-20(1959) July.

The extraction of Np with TBP was studied with emphasis on its oxidation states. The solvent systems studied were HNO_3–TBP, H_2SO_4–TBP, and $HClO_4$–TBP. The isolation of Np from irradiated uranyl nitrate was studied. (J.E.D.)

TRANSURANICS - SEPARATION OF
Neptunium 2.54.05

16998 AERE-C/R-1893
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
CHEMICAL STUDIES RELATING TO THE RECOVERY OF NEPTUNIUM FROM THE WINDSCALE PLANT. E. Hesford and H. A. C. McKay. Feb. 1956. Decl. June 1958. 20p. $0.54(BIS).

The oxidation and reduction of neptunium were studied spectrophotometrically in solutions similar to those from which neptunium might be recovered at Windscale. It has been shown that the use of hydrazine as a reductant is complicated by the catalytic effect of iron on the destruction of the reagent. Attempts to recover Np^{237} from Windscale highly active fission product effluent were partially successful. (auth)

RECOVERY OF NEPTUNIUM-237 FROM SPECIAL HANFORD WASTES. H. B. Evans, W. B. Seefeldt and H. H. Hyman. Mar. 27, 1950. Decl. Feb. 27, 1957. 26p. (ANL-4442)

A method is presented for the recovery of Np^{237} from special Hanford Pu waste solutions by a batch solvent extraction process. This procedure which is moderately successful utilizes the behavior of Np^{+4} to form highly solvent-soluble nitrate complexes in the presence of certain organic amines or quaternary salts under conditions where Pu^{+3} can be stabilized. A discussion of the feasibility of continuous countercurrent extraction for the separation of Np from Pu is given.

8747
THE RECOVERY OF NEPTUNIUM-237. J. S. Nairn and D. A. Collins (United Kingdom Atomic Energy Authority, Windscale, Cumb., Eng.). pp. 518-33 in "Progress in Nuclear Energy. Series III. Process Chemistry. Volume 2."

Neptunium-237 has been recovered in gram quantities from large volumes of waste solution containing this element in an extremely low concentration. Both solvent extraction and anion-exchange processes for recovery were examined. The process selected involved concentration with an anion-exchange resin. The concentrated eluate was purified by a solvent cycle in which the neptunium, as neptunium(IV), was extracted into thenoyltrifluoroacetone–benzene. A final anion-exchange stage removed the last traces of added reagents and provided a solution of neptunium nitrate.

Argonne National Lab., Lemont, Ill.
CHEMICAL METHODS FOR THE PURIFICATION AND ISOLATION OF NEPTUNIUM. L. B. Magnusson, J. C. Hindman, and T. J. LaChapelle. Oct. 10, 1947. ~~Decl.~~ Dec. 15, 1955. 33p. Contract W-31-109-eng-38. $0.30(OTS). (ANL-4066)

Methods for separating Np from various types of source material are outlined. For the purpose of analytical classification Np may be grouped with U and Pu since all three elements, mixed in an aqueous solution, can be oxidized to a characteristic +6 state. An excellent separation from other metal ions is obtained by extraction of the +6 states into diethyl ether. Methyl isobutyl ketone is also an effective extracting solvent although it is not as specific. All three elements in the +6 state will precipitate with sodium as double acetates of the formula $NaXO_2(OOCCH_3)_3$. Neptunium may be separated from U and Pu by solvent extraction or precipitation. Np(IV) forms a benzene soluble, chelate complex with thenoyl trifluoroacetone. Under suitable reducing conditions Np(IV) can be extracted away from Pu(III) and U(VI). A separation method involving the precipitation of fluorides is essentially dependent on the relative rates of oxidation and reduction of U, Np, and Pu.

8746
THE DEVELOPMENT OF RECOVERY PROCESSES FOR NEPTUNIUM-237. J. R. Flanary and G. W. Parker (Oak Ridge National Lab., Tenn.). pp. 501-17 in "Progress in Nuclear Energy. Series III. Process Chemistry. Volume 2."

Gram quantities of neptunium-237 were recovered from irradiated natural uranium, irradiated enriched uranium and fluorination ash from depleted uranium by extraction with tributyl phosphate. The flowsheet from natural uranium is a modified Purex flowsheet, with simultaneous extraction of plutonium, uranium, and neptunium(VI) and partitioning by acidity adjustment. Final concentration and purification are by ion exchange. For enriched uranium the Neptex process, which is similar to the 25-TBP process, is used. There is no plutonium present and neptunium is extracted in the tetravalent state. The process used with fluorination ash is similar to the Neptex second cycle. (auth)

TRANSURANICS-SEPARATION OF
Neptunium 2.54.05

14634 A/CONF.15/P/942
Argonne National Lab., Lemont, Ill.
SOME RECENT STUDIES WITH HEXAFLUORIDES. Bernard Weinstock and John G. Malm. 10p. $0.50 (OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

A method of preparation for NpF_6 in gram quantities is described, and the results of studies with this compound as well as recent work with UF_6 and PuF_6 are presented. The physical properties of these three compounds behave in an anomalous fashion; a thermodynamic basis to explain this behavior is given. Preceding the 5f transition series hexafluorides is another group of hexafluorides formed by the 5d transition series elements, W, Re, Os, Ir, and Pt. The preparation and study of OsF_6 is reported; this is of particular interest since this compound has been shown to be identical with the previously reported OsF_8. An octafluoride has never been prepared and the compound previously reported as OsF_8 was also incorrectly identified. The first preparation of a hexavalent compound of platinum, PtF_6, is also described as well as some of its properties. This compound appears to be the most reactive and unstable of all the hexafluorides. (auth)

2201 HW-51958
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
THE EXTRACTION OF NEPTUNIUM(IV) AND PLUTONIUM (IV) FROM NITRIC ACID SOLUTION WITH TRI-N-OCTYL AMINE. John C. Sheppard. Aug. 22, 1957. Decl. Oct. 23, 1957. 13p. Contract [W-31-109-Eng-52]. $3.30 (ph OTS); $2.40(mf OTS).

Tri-n-octylamine conveniently extracts neptunium(IV) and plutonium(IV) from nitric acid solutions. Preliminary experiments to demonstrate the utility of this type of reagent have been performed; in particular the extraction of neptunium or plutonium from Purex waste streams has been demonstrated. Experiments have also been performed to determine what may be expected in the way of fission product decontamination and radiation stability of tri-n-octylamine. Fission product decontamination is not appreciably altered by the organic phase being highly irradiated. This report describes preliminary work designed to determine the solvent extraction characteristics of tri-n-octylamine in the nitric acid system. In particular the solvent extraction behavior of neptunium and plutonium has been investigated. (auth)

1315
THE EXTRACTION OF INDIVIDUAL FISSION PRODUCTS FROM CHEMICAL PROCESS WASTES. Presented at the International Conference on Radioisotopes in Scientific Research, Sept. 9-20, 1957 at Paris. No. UNESCO/NS/RIC/16. K. Saddington. London, Pergamon Press, Ltd., 1957. 20p.

Methods are described which have been used in the U.K.A.E.A. for producing from fission product waste solutions radioactive sources of two different types: Intense sources (1,000-2,000 curies) of Cs^{137} for use in medicine, industry and as a research tool; smaller sources for chemical studies and research applications, of unusual isotopes, such as Np^{237}, which have hitherto been available, if at all, only in milligram quantities. (auth)

11121 HW-50311
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
RADIOCHEMICAL PROCEDURES FOR THE SEPARATION OF TRACER AMOUNTS OF Na^{24}, Mn^{56}, Cu^{64} AND Np^{239} FROM REACTOR EFFLUENT WATER. R. W. Perkins. June 4, 1957. 7p. Contract [W-31-109-Eng-52]. $1.80 (ph OTS); $1.80(mf OTS).

9620 CF-56-9-83
Oak Ridge National Lab., Tenn.
SEPARATION AND DETERMINATION OF NEPTUNIUM BY LIQUID-LIQUID EXTRACTION. Fletcher L. Moore. Sept. 25, 1956. 12p. Contract [W-7405-Eng-26]. $3.30(ph OTS); $2.40(mf OTS).

A rapid and quantitative radiochemical method for the determination of Np^{237} or Np^{239} tracer is described. The method is based on the liquid-liquid extraction of Np(IV) into 0.5M 2-thenoyltrifluoroacetone–xylene. Neptunium is separated free from interferences, both radioactive and non-radioactive, and the method may be adapted readily to remote control. The technique has also been found to be very effective in the purification of Np tracer. (auth)

TRANSURANICS-SEPARATION OF

Neptunium 2.54 05

SOLVENT EXTRACTION OF NEPTUNIUM. J. P. Butler (to U. S. Atomic Energy Commission). U. S. Patent 2,847,276. Aug. 12, 1958.

A process is described for the recovery of neptunium from dissolver solutions by solvent extraction. The neptunium containing solution should be about 5N, in nitric acid and about 0.1 M in ferrous ion. The organic extracting agent is tributyl phosphate, and the neptunium is recovered from the organic solvent phase by washing with water.

14411

OXIDATIVE METHOD OF SEPARATING PLUTONIUM FROM NEPTUNIUM. L. J. Beaufait, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 2,838,366. June 10, 1958.

A method is described of separating neptunium from plutonium in an aqueous solution containing neptunium and plutonium in valence states not greater than +4. This may be accomplished by contacting the solution with dichromate ions, thus oxidizing the neptunium to a valence state greater than +4 without oxidizing any substantial amount of plutonium, and then forming a carrier precipitate which carries the plutonium from solution, leaving the neptunium behind. A preferred embodiment of this invention covers the use of lanthanum fluoride as the carrier precipitate.

SEPARATION PROCESS FOR TRANSURANIC ELEMENT AND COMPOUNDS THEREOF. Lawrence B. Magnusson (to U.S. Atomic Energy Commission). U.S. Patent 2.830,066. Apr. 8, 1958.

A process is described for the separation of neptunium, from aqueous solutions of neptunium, plutonium, uranium, and fission products. This separation from an acidic aqueous solution of a tetravalent neptunium can be made by contacting the solution with a certain type of chelating agent, preferably dissolved in an organic solvent, to form a neptunium chelate compound. When the organic solvent is present, the neptunium chelate compound is extracted; otherwise, it precipitates from the aqueous solution and is separated by any suitable means. The chelating agent is a fluorinated β-diketone, such as trifluoracetyl acetone.

14687 A/CONF.15/P/520

Du Pont de Nemours (E.I.) & Co. Savannah River Lab., Augusta, Ga.

CONCENTRATION AND PURIFICATION OF URANIUM, PLUTONIUM, AND NEPTUNIUM BY ION EXCHANGE IN NUCLEARLY SAFE EQUIPMENT. F. W. Tober. 19p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

The initial products from the processing of irradiated fuel elements are usually relatively dilute solutions of uranium, plutonium, or neptunium which must be concentrated and further purified. Ion exchange has proved to be a useful method for accomplishing these objectives. Several isotopes which are, or accidentally could be, present in the process streams are fissionable. All the equipment, therefore, must be designed to prevent the accumulation of fissionable material which could generate an excessive amount of neutrons by multiplication. Even with the limitations imposed to provide nuclear safety, the processing can be done economically by ion exchange because a large batch of product can be absorbed, purified, and eluted within a short period of time. Nuclear safety is easily obtained by using resin beds with small diameters, or by using a composite column that consists of a series of shallow beds separated sufficiently to avoid interaction of the neutrons from the individually safe beds. Rapid processing is obtained by using the maximum flowrates that are practical. The rates of processing are directly proportional to the cross-sectional area but are independent of the depth of resin in the ion exchange column. General requirements that are common to all the processes are discussed, together with separate discussions of processes for uranium, plutonium, and neptunium.

TRANSURANICS - SEPARATION OF
Neptunium 2 54.05

10852 HW-59193
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
CONCENTRATION AND FINAL PURIFICATION OF NEPTUNIUM BY ANION EXCHANGE. J. L. Ryan. Feb. 10, 1959. 15p. Contract W-31-109-Eng-52. $3.30(ph), $2.40(mf) OTS.

The final separation and purification of Np from Pu, U, fission products, Th, and common metallic impurities were investigated. It was found that Np(IV) can be absorbed on anion exchange resins from 6 M HNO_3 containing ferrous sulfamate and hydrazine. Procedure for eluting other metals from the resin are given as well as separation efficiencies. The choice of resin is listed along with elution techniques and a flowsheet. (J.R.D.)

RECOVERY OF NEPTUNIUM-237 FROM PROCESS RESIDUES BY SOLVENT EXTRACTION. J. R. Flanary and J. H. Goode (Oak Ridge National Lab., Tenn.). Ind. Eng. Chem. 51, 55-7(1959) Jan.

A solvent extraction process, utilizing tributyl phosphate as the extractant, was developed and proved on a semiworks scale for the separation of neptunium from processing residues. This extends the usefulness of tributyl phosphate as a solvent for the recovery of the heavy elements, adding neptunium to thorium, uranium, and plutonium. Standard laboratory techniques of batch equilibrations and batch countercurrent experiments, using tracer techniques, established optimum conditions for primary extraction of uranium and neptunium and their separation. Results of these tests were confirmed in a pulsed column demonstration. (auth)

SEPARATION OF NEPTUNIUM FROM PLUTONIUM BY CHLORINATION AND SUBLIMATION. S. M. Fried (to U. S. Atomic Energy Commission). U. S. Patent 2,860,948. Nov. 18, 1958.

A process is described for separating neptunium from plutonium. The method consists in chlorinating a mixture of the oxides of Np and Pu by contacting the mixture with carbon tetrachloride at about 500°C. In this manner the Np is converted to the tetrachloride and the Pu is converted to the trichloride. Since $NpCl_4$ is more volatile than $PuCl_3$, the separation is effected by vaporizing and subsequently condensing the $NpCl_4$.

5336 ORNL-2642
Oak Ridge National Lab., Tenn.
PREPARATION OF HIGH PURITY NEPTUNIUM ON MULTI-GRAM SCALE. P. M. Lantz, W. J. Martin, and G. W. Parker. Jan. 22, 1959. 25p. Contract W-7405-eng-26. $1.00(OTS).

This work was undertaken as an extension of this laboratory's effort to prepare and stock-pile multigram quantities of high-purity Np^{237} for research uses. The preliminary step in the purification of 116 grams was performed by preparing 81 liters of neptunium concentrate from several tons of Paducah Diffusion Plant Ash. The object of this investigation was of a dual nature: first, to develop a process to remove a sixty-fold thorium contamination and traces of uranium, plutonium, and the usual plant corrosion products down to less than one part per million by weight; and secondly, to improve the efficiency of the Metal Recovery Plant's neptunium purification. In connection with the second objective several aspects of the neptunium purification process were investigated, such as hydrogen peroxide stabilization of Np(V), $NO_2^- - HNO_3$ oxidation of Np(V) and a thorium–neptunium separation involving a low percent of tri-n-butyl phosphate. The Nethix-1 flowsheet was developed and successfully applied to the clean up of the neptunium concentrate, providing a product with less than one part per million of thorium, uranium, or plutonium. It was further determined that hydrogen peroxide is an effective stabilizer for Np(V) in the 1 M HNO_3 solutions and that the decontamination factor for thorium is approximately 20 for each stage height in a 5% TBP–HNO_3 system. (auth)

PRECIPITATION METHOD OF SEPARATION OF NEPTUNIUM. L. B. Magnusson (to U. S. Atomic Energy Commission). U. S. Patent 2,841,464. July 1, 1958.

A process is described for the separation of neptunium from plutonium in an aqueous solution containing neptunium ions in a valence state not greater than +4, plutonium ions in a valence state not greater than +4, and sulfate ions. The process consists of adding hypochlorite ions to said solution in order to preferentially oxidize the neptunium and then adding lanthanum ions and fluoride ions to form a precipitate of LaF_3 carrying the plutonium, and thereafter separating the supernatant solution from the precipitate.

5281
EXTRACTION OF Np^{239} FROM IRRADIATED URANIUM. E. S. Pal'shein and Yu. Z. Zolotov. Radiokhimiya 1, 482-7(1959). (In Russian)

An efficient extraction method is suggested for recovering radiochemically pure Np^{239} from irradiated uranium; the extraction is completed within 1 to 2 hours. The behavior of certain fragments during Np^{239} extraction by diethyl ether was analyzed. (R.V.J.)

5251 HW-59193(Rev.)
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
CONCENTRATION AND FINAL PURIFICATION OF NEPTUNIUM BY ANION EXCHANGE. J. L. Ryan. Feb. 10, 1959. Revised Sept. 3, 1959. 18p. Contract AT(45-1)-1350. OTS.

It was demonstrated that neptunium(IV) can be readily absorbed onto anion exchange resins from 6 M HNO_3 containing ferrous sulfamate and hydrazine or semicarbazide, separated from plutonium, uranium, and common metallic impurities by washing the resin at 25°C with 6 M HNO_3 containing ferrous sulfamate and hydrazine or semicarbazide, separated from fission products and thorium by washing the resin at 60°C with 8 M HNO_3 – 0.01 M HF containing hydrazine or semicarbazide, and eluted at concentrations greater than 40 g Np/l.with 0.35 M HNO_3 at 25°C. Decontamination factors of greater than 10,000 from uranium, plutonium, and common metallic contaminants, greater than 25,000 for fission products normally expected in the feed (mainly Zr-Nb with some Ru-Rh), and greater than 1000 for thorium are obtainable under proper operating conditions. Because of the low processing rates, the necessity for carrying out the absorption cycle at 25°C and the absence of radiation damage problems, Dowex 1, X-4 (50 – 100 mesh) or Dowex 21K (50 – 100 mesh) resins are considered the best choices for this application. Gassing occurs with the use of ferrous sulfamate – semicarbazide reductant but is not a serious problem and does not occur with ferrous sulfamate – hydrazine reductant in 6 M HNO_3. (auth)

TRANSURANICS-SEPARATION OF
Neptunium 2.54.05

5151 ANL-4224
Argonne National Lab., Lemont, Ill.
THE SEPARATION OF NEPTUNIUM FROM PLUTONIUM BY A VOLATILIZATION METHOD. Sherman Fried. Nov. 23, 1948. Decl. Dec. 13, 1955. 9p. Contract W-31-109-eng-38. (ANL-WMM-437). $0.15(OTS).

It has proved possible to separate Np from Pu by a volatilization method involving the fractional sublimation of the chlorides. The chlorides are formed by the action of CCl_4 vapor at 650°C on the mixed oxides, $PuCl_3$ being formed from the PuO_2 fraction and $NpCl_4$ from the NpO_2. The large difference in vapor pressures of the two compounds at 450°C (less than 10^{-6} mm. for $PuCl_3$ and ca. 10^{-1} mm. for $NpCl_4$) permits the separation of the two compounds by fractional sublimation at that temperature. The starting material contained approximately 4% Pu by weight as determined by differential pulse analysis and the final product contained less than 10^{-3}% (the limit of detection). The separation is thus of the order of 3×10^3. This process has been carried out on the 100-μg scale up to the 65 mg scale and the yield of usable material obtained in most cases was of the order of 96%. (auth)

TRANSURANICS - SEPARATION OF
Nobelium 2.54.06

14723 A/CONF.15/P/825
California. Univ., Berkeley. Radiation Lab.
METHODS OF PRODUCTION AND RESEARCH ON TRANSCURIUM ELEMENTS. Stanley G. Thompson and M. Luis Muga. 43p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

Progress in the methods used for the production of transcurium isotopes since 1955 is summarized. Experimentally determined isotopic compositions resulting from long-term irradiations of isotopes in the Materials Testing Reactor are given. Tables of neutron cross sections consistent with the experimental data are listed. Calculated curves for isotopic compositions as a function of neutron flux and time are given for neutron fluxes as high as 5×10^{15}. A summary of the information available on the chemical properties of the transcurium elements is given emphasizing develop-

TRANSURANICS-SEPARATION OF Nobelium 2.54.06

12330

ELEMENT NO. 102. A. Ghiorso, T. Sikkeland, J. R. Walton, and G. T. Seaborg (Univ. of California, Berkeley). Phys. Rev. Letters 1, 18-21(1958) July 1.

An unambiguous identification of an isotope of element 102 was made by a radically new method. The chemical identification of an isotope of fermium (Fm^{250}) as the daughter of an α-emitting isotope of element 102 (102^{254}) was carried out. The method used to detect the isotope of element 102 was essentially a continuous milking experiment wherein the atoms of the daughter element 100 were separated from the parent element 102 by taking advantage of the recoil due to the element 102 α decay. (L.T.W.)

999

NEWS ON ELEMENT NO. 102. V. I. Gol'danskiĭ. Soviet Phys.-Uspekhi 2, No. 1, 183-6(1959) Jan.-Feb.

Two methods of synthesizing the element nobelium are given. The method of bombarding Pu^{239} and Pu^{240} with oxygen ions at 100 Mev is described. Alpha particles of 8.8 ± 0.5 Mev are reported for 87 cases from the above method. The second method, also based on nuclear-recoil, uses a curium target containing 5% of the isotope Cm^{246} (95% Cm^{244}) which is bombarded with C^{12} ions of 60 to 100 Mev energy. The nobelium atoms produced are slowed down by a helium atmosphere. The half life of No^{254} was determined to be ~3 sec from the above reaction. (C.J.G.)

10420

ELEMENT 102. Z. G. Atomnaya Energiya 3, 265(1957).

Element 102 nobelium was obtained from the reaction $Cm^{244} + C^{13}$ at Stockholm. The new isotope has the mass number 251 to 253, disintegrates with a half life of 10 min, and emits α particles with an energy of 8.5 Mev. (TCO)

TRANSURANICS -SEPARATION OF General 2.54.07

20885 HW-60552

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

SEQUENTIAL SEPARATION OF SOME ACTINIDE ELEMENTS BY ANION EXCHANGE. F. P. Roberts and F. P. Brauer. June 1, 1959. 9p. Contract W-31-109-Eng-52. $1.80(ph), $1.80(mf) OTS.

Methods are presented by which trace amounts of several actinide elements are separated. Use is made of the large differences in distribution coefficients, so careful chromatographic techniques are not necessary. Small columns are used, allowing the desired constituent to be obtained in 10 ml or less. One method is used to separate americium, plutonium, and neptunium. These elements are sequentially eluted from columns of Dowex 1 resin in that order by 8 M HNO_3, 0.02 M ferrous sulfamate in 4.5 M HNO_3, and 0.001 M ceric sulfate in 0.25 M HNO_3. Another method is used to separate americium, thorium, plutonium, and neptunium sequentially in that order by 8 M HNO_3, 12 M HCl, 12 M HCL-0.1 M NH_4I, and 4 M HCL by elutriation. Protactinium and uranium follow the americium in both methods. The methods presented are characterized by a low degree of cross contamination. Yields are greater than 95 percent. (auth)

BERKELIUM AND CALIFORNIUM. B. B. Cunningham (Univ. of California, Berkeley). J. Chem. Educ. 36, 32-7 (1959) Jan.

A brief review of the discovery and formation of berkelium and californium is given. Isotopes Bk^{243} and Cf^{245}, plus those prepared since the initial discovery, are listed. The tabulation includes information on half life, mode of disintegration, and source. Discussions are presented on chemical properties of the elements, chemical investigations by tracer techniques, and isotopic composition. (J.H.M.)

TRANSURANICS-SEPARATION OF
General 2.54.07

2844
THE SYNTHESIS OF REMOTE TRANSURANIAN ELEMENTS. Priroda 48, No. 8, 83-4(1959) Aug. (In Russian)
A short review is presented on synthesis methods. (R.V.J.)

2451
PROCEEDINGS OF THE SECOND UNITED NATIONS INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, HELD IN GENEVA, 1 SEPTEMBER–13 SEPTEMBER 1958. VOLUME 20. ISOTOPES IN RESEARCH. Geneva, United Nations, 1958. 272p. $10.00.
Recent developments in the production and use of isotopes are presented. The trend of future developments in various fields of research is discussed by various papers. The manufacture of isotopes in reactors and linear accelerators, the enrichment of specific activity by chemical means, and the synthesis of labeled compounds are discussed. Other papers describe diffusion studies, exchange reactions, stable isotopes and radiochemistry. (W.L.H.)

14725 A/CONF.15/P/2247
Los Alamos Scientific Lab., N. Mex.
RECENT ADVANCES IN THE BASIC CHEMISTRY OF PLUTONIUM, AMERICIUM AND CURIUM. S. W. Rabideau, L. B. Asprey, T. K. Keenan, and T. W. Newton. 17p. $0.50(OTS).
Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.
The oxidation-reduction potentials of plutonium in acid solutions were determined, enabling the estimation of equilibrium relationships among the aqueous plutonium species from electromotive force, spectrophotometric, and kinetic data. Advances in the chemistry of americium and curium included the discovery and isolation of new valence states and characterization of the metals and compounds. The results of studies of the reactions between plutonium species with each other, with oxygen, V(III), and U(IV) are presented, along with a discussion of solid phase studies of americium and curium. (J.R.D.)

AMERICIUM AND NEPTUNIUM RECOVERY PROCESSES. W. H. Lewis. 13p. (A/CONF.15/P/537)
Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.
Solvent extraction processes were developed on a pilot plant scale for recovering Np^{237} and Am^{241} from irradiated U and fuel cycle wastes. Np was recovered from irradiated normal U, irradiated enriched U alloyed with Al and fluorination ash produced from the conversion of recovered UO_3 to UF_6. Am was separated from a fuel cycle waste containing large quantities of La and Ce. Final purification of both Am and Np from solvent extraction processes was achieved by ion exchange. A detailed description of these processes is presented.

14345 TID-7556(p.49-61)
Argonne National Lab., Lemont, Ill.
HOT LABORATORY PROBLEMS IN ISOLATING GRAM QUANTITIES OF TRANSPLUTONIUM ELEMENTS. C. H. Youngquist and P. R. Fields. p.49-61 [of] SIXTH HOT LABORATORIES AND EQUIPMENT CONFERENCE, MARCH 19-21, 1958, INTERNATIONAL AMPHITHEATRE, CHICAGO, ILLINOIS. 13p.
It is shown how the experience gained in processing small research quantities of irradiated plutonium will be applied to the processing of irradiated plutonium fuel assemblies. The material being processed is about 300 times greater than the earlier research samples and will present problems in methods and equipment for processing. In addition, the proportionately higher neutron emission from the transplutonium elements will require the use of neutron caves as a substitute for glove boxes. (auth)

6467 A/CONF.15/P/1458
THE EXTRACTION OF ACTINIDE ELEMENTS FROM WASTES. J. S. Nairn and D. A. Collins (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.), H. A. C. McKay (Atomic Energy Research Establishment, Harwell, Berks, Eng.), and A. G. Maddock (Cambridge Univ., Eng.). 55p.
As a result of the industrial production of uranium and plutonium, significant quantities of other actinide elements accumulate in wastes, and their recovery has aided investigation of their chemistry. This paper describes methods used to extract gram quantities of Th^{230}, Pa^{231}, and Np^{237} from relevant process wastes. The extraction of Am^{241} from highly irradiated plutonium is also described. (auth)

ments of the past three years. Recently developed techniques and methods are described for the preparation and handling of targets for charged particle bombardments. Methods used for rapid separations by chemical and recoil methods are described. Data are given concerning several types of procedures for preparing thin sources. A summary is given of the cross sections for the production of transcurium isotopes in bombardments with charged particles and very heavy ions; a method for calculating the excitation functions for heavy ion reactions is included. (auth)

2029 CF-3211
Hanford Engineer Works, Richland, Wash.
CORRELATIONS AND PREDICTIONS CONCERNING THE RADIOACTIVE PROPERTIES OF HEAVY ISOTOPES. W. H. Sullivan and T. P. Kohman—I. Perlman, ed. Aug. 4, 1945. Decl. Feb. 16, 1957. 14p. Reissued under auspices of Contract W-7401-eng-37. (HW-3-3048; SE-PC-68). $3.30(ph OTS); $2.40(mf OTS).

Correlations of data concerning known heavy isotopes were made to predict the formation of other heavy isotopes in the pile. How these isotopes will affect chemical processing and Pu product is discussed. (T.R.H.)

USES OF
-Chemistry 2.55.01

APPLICATION OF THORIA-IRIDIUM AS THE SOURCE OF IONIZING ELECTRONS IN MASS SPECTROMETRY. C. E. Melton (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr. 29, 250(1958) Mar.

In mass spectrometric studies of the photolysis of chlorine and formic acid to produce hydrogen chloride and carbon dioxide, a source pressure of 10^{-5} mm Hg is required; consequently, the principal instrumental difficulty encountered is burnout of the tungsten filament used to produce ionizing electrons. Due to the reaction of chlorine the filament must be replaced after each eight hours of service. The use of thoria-iridium as a filament in a mass spectrometer is discussed. This filament has a lower operating temperature, is chemically resistant to corrosive gases, has constant emission characteristics, and has a long life. (A.C.)

13701 TID-3513
Technical Information Service Extension, AEC.
ISOTOPES IN BIOCHEMISTRY AND BIOSYNTHESIS OF LABELED COMPOUNDS. A Selected List of References. J. A. McCormick, comp. Mar. 1958. 89p. $2.25(OTS).

This bibliography contains 2430 selected references on uses of radioisotopes in biochemistry and biosynthesis of labeled compounds. These references were taken from the 1948 to 1956 open literature. A list of the journals from which the references were selected and an author index are also included. (auth)

14633 A/CONF.15/P/937
Oak Ridge National Lab., Tenn. and Florida. Univ., Gainesville.
THE USE OF F^{18} IN PREDICTING CATALYTIC REACTIONS. John A. Wethington, Jr., T. A. Gens, W. H. Christie, and A. R. Brosi. 10p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

F^{18} was used to study exchange reactions between metallic fluorides and fluorocarbons at room temperature. Cesium fluoride was the most reactive salt, however, measurable exchange was observed with all of the alkali fluorides. Perfluoropropene exchanged more readily than CF_4, C_4F_{10}, or $(C_2F_5)_2O$; however, measurable reaction was observed in all cases. Detailed studied with perfluoropropene and cesium fluoride at 0°C showed that the gas underwent exchange with the first ten to forty layers of the crystal at a rate too fast to be measured. This fast reaction was followed by a slow, apparently zero-order reaction, which if allowed to proceed, reached isotopic equilibrium with the entire crystal. Changes within the crystal could also be followed as the reactions proceeded. The oxidation of perfluoropropene was then studied using these inorganic fluorides as catalytic surfaces. The alkali fluorides were found to be excellent oxidation catalysts, and the ability of these salts to catalyze the oxidation reaction was in the same order as the extent of the fast initial exchange reaction. The distribution of products obtained when the salts were used as a reactor packing was vastly different from the products obtained from the thermal reaction. Processes within the crystal, were found to agree with those predicted by the exchange reactions. (auth)

USES OF
- Chemistry 2.55.01

5560 BNL-389
Brookhaven National Lab., Upton, N. Y.
FISSION PRODUCTS UTILIZATION. VIII. STUDIES ON THE USE OF RADIATION AS A CATALYST FOR CHEMICAL REACTIONS. Progress Report. D. S. Ballantine and B. Manowitz. May 1956. 25p. $0.25(OTS).

Polyvinylpyrrolidone, has been prepared by gamma irradiation of dilute aqueous solutions of the monomer, N-vinylpyrrolidone. The kinetics of the reaction indicate that rate of polymerization is a function of monomer concentration to the first power, and of intensity to the one-half power. The molecular weight, expressed as an empirical K value, increased with monomer concentration, decreased with increased intensity, and varied widely with the solvent used. Polyester formulations of unsaturated linear polyesters with styrene or other monomers were "cured" by exposure to gamma ray dosages of less than one million rep. The rate of cure is increased by raising the intensity, but appears to be insensitive to increases in temperature between 30° and 80°C. The printability and adhesive properties of polyethylene films have been improved by exposure of films to γ's in an oxygen-containing atmosphere. Hydrocarbon waxes have been irradiated in an attempt to improve physical properties. Evidence of physical changes was obtained only after irradiation dosages in excess of 100 million rep. Butadiene was adsorbed on carbon black and irradiated with gamma. Preliminary results indicate that a polymerization occurred but the results are not completely reproducible. Wood has been impregnated by equilibrium soaking with vinyl monomers which were polymerized in situ by exposure to gamma radiation. Uranyl nitrate has been dissolved in methanol and irradiated for a short period. The fission recoils caused much gassing and slight conversion of the methanol to formaldehyde and ethylene glycol. (For preceding period see BNL-317.) (auth)

1835
RADIOACTIVE ISOTOPES IN TECHNOLOGY. P. E. D'yachenko. Vestnik Akad. Nauk S.S.S.R. 25, 37-47(1955) Oct. (In Russian)

A review. (R.V.J.)

4132
THE THEORY OF ISOTOPIC METHODS IN THE INVESTIGATION OF CHEMICAL REACTIONS. S. Z. Roginskii. Publishing House of the Academy of Sciences, U.S.S.R. Moscow, 1956. 611p. (In Russian)

Information is included on thermodynamic isotopic effects, kinetics of noncomplicated isotopic exchange, mechanisms and stages of isotopic exchange, isotopic effects in chemical kinetics, kinetics of complex isotopic exchange, and the basic areas of applications and perspectives of development of isotopic methods in chemical kinetics. Tables of thermodynamic functions, isotopic exchange equilibrium constants, and tables developed according to the kinetic isotopic effects of isotopic exchange are included in the appendix. (R.V.J.)

4019 AEC-tr-2435((Pt. 2) (p. 129-44)
INVESTIGATION OF THE STRUCTURES AND REACTIVITIES OF COMPOUNDS WITH THE AID OF ISOTOPES. A. I. Brodsky [Brodskii]. p. 129-44 of CONFERENCE OF THE ACADEMY OF SCIENCES OF THE USSR ON THE PEACEFUL USES OF ATOMIC ENERGY, JULY 1-5, 1955. SESSION OF THE DIVISION OF CHEMICAL SCIENCE. (Translation). 16p.

6494 A/CONF.15/P/2209
O PERSPEKTIVAKH ISPOL'ZOVANIYA OSKOLOCHNYKH ISLUCHATELEI V RADIOATSIONNO-KHIMICHESKIKH PROTSESSAKH. (Prospects of Using Fission Product Source Radiation in Radiation Chemistry.) P. V. Zimakov, A. V. Fokin, et al. (U.S.S.R.). 12p.

The method of obtaining hard fission product sources as castings of various shapes is outlined, in which the radioactive isotopes are tightly fastened on the carrier. The application of such sources of ionizing radiation to carry out chemical reactions is discussed. The method consists in concentrating and solidifying waste radioactive solutions and in subsequent fusing solid concentrates with various fluxes, so that sources of any shape may be obtained. The results of experimental research on the application of fission product sources in a number of chemical processes are described. (auth)

USES OF
- Chemistry 2.55.01

CHEMICAL REACTIONS. (to Esso Research and Engg. Co. (U.S.A.)). British Patent 785,611. Nuclear Eng. 3, 228(1958) May.

The steady accumulation of radioactive by-products or waste materials in the operation of atomic piles presents a disposal problem. The difficulty can be alleviated by using the material for certain reactions. The radioactive material is maintained in the lower portion of a ground excavation under a shielding material. The reactant material is introduced or kept in the lower part of the excavation sufficiently close to the radioactive material to allow the radiation to reach the reactants. It is preferred to expose the reactants to radiation emitted by the fission by-products of processes generating atomic power and/or fissionable materials. The activation of chemical reactions by high-energy ionizing radiation is somewhat complicated by the fact that most reactions are between elements of low atomic number (21 or lower), which do not effectively absorb, e.g., gamma-rays. Such mixtures can be sensitized by incorporating elements of high atomic number (22 or greater; preferably 74), such as mercury in the form of a solution, suspension or emulsion or as mercury vapor in a hydrocarbon mixture. Ultrasonic vibration may be introduced to obtain more uniform or more stable emulsions or suspensions. Instead of elements of high atomic number, compounds may be used. The additions may range between 1 and 5% of the reactants. The method may also be applied to chain reactions which involve the production of free radicals. Water may be maintained in the pit as a transparent shield over a thin layer of concrete covering the concrete or metal-lined pit.

1320

THE APPLICATION OF RADIOACTIVE ISOTOPES FOR DEVELOPING NEW METHODS IN ANALYTICAL CHEMISTRY. ORGANIC COPRECIPITANTS. Presented at the International Conference on Radioisotopes in Scientific Research, Sept. 9-20, 1957 at Paris. No. UNESCO/NS/RIC/46. V. I. Kuznetsov. London, Pergamon Press, Ltd., 1957. 17p.

14612 A/CONF.15/P/934

Princeton Univ., N. J.

THE USE OF ISOTOPES AND RADIATION IN THE STUDY OF HETEROGENEOUS CATALYSIS. John Turkevich. 8p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

A review is given of the contributions made to the study of the mechanism of heterogeneous catalysis using radioactive and stable isotopes. Further, a review is presented on the effect of high energy radiation on catalytic activity. In addition, results on the use of deuterium to characterize the catalytic activity of carbons before, during, and after radiation damage are presented. These results are compared with those obtained by thermal treatment. The subsidiary techniques of ortho-para hydrogen conversion and electron spin resonance are used to explain the nature of catalytic activity. (auth)

7273

DETERMINATION OF CONCENTRATIONS BY β BACKSCATTERING. Louis Danguy. Intern. J. Appl. Radiation Isotopes 2, 90(1957) Apr. (In French)

13747 AERE-Lib/Trans-788

USE OF RADIOACTIVE ISOTOPES IN ANALYTICAL CHEMISTRY. I. P. Alimarin and N. A. Rudnev. Translated by S. Botcharsky (U.K.A.E.A., Atomic Energy Research Establishment) from Z. Anal. Khim. 12, 587-92(1957). 9p.

Methods of using radioisotopes in analytical chemistry are briefly reviewed. Problems of the theory of analytical chemistry, separation of the elements, and quantitative determination of the elements are noted. (J.E.D.)

13331 AEC-tr-3719

APPLICATIONS OF RADIOISOTOPES TO PHYSICAL-CHEMICAL INVESTIGATIONS. J. M. Gamboa. Translated for Oak Ridge National Lab. from Energia nuclear (Madrid) 1, 53-66(1957). 48p. (Includes original, 14p.). $7.80(ph), $3.30(mf) JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, as abstract No. 2038.

USES OF
- Chemistry 2.55.01

6053 A/CONF.15/P/2520
PRODUCTION AND USE OF RADIOISOTOPES IN RESEARCH. U. N. Survey Paper. Henry Seligman ([Atomic Energy Research Establishment, Harwell, Berks, Eng.]). 8p.

The highlights of recent developments and trends of recent developments in the various research fields are touched upon. A survey is made of the papers on radioisotopes presented at the Geneva Conference. Almost half of the papers deal with the production of radioactive material in reactors or linear accelerators or by chemical enrichment. (W.D.M.)

6442 A/CONF.15/P/985
EXAMPLES FOR THE APPLICATION OF FISSION PRODUCTS AS TRACERS IN THE FIELD OF CHEMISTRY. Hans Götte (Farbwerke Hoechst AG., Frankfurt am Main). 12p.

Some short-lived radionuclides which are useful radio tracers can be produced only by fission. Especially useful are those whose long-lived mother substances can be isolated so that the short-lived radionuclides may be prepared repeatedly for use in any distance of the isotope production center. For long-lived fission products applications have to be found as they form the waste. They should therefore be used, if possible, instead of radionuclides formed by (n,γ) processes. As fission products can be produced carrier-free, preparations of high specific activity are attainable. Examples are given for the application of both kinds of fission products, and an investigation with a mixture of fission products is also mentioned. (auth)

USES OF
-General (Surveys) 2.55.02

1185 TID-3046(Suppl. 2)
Office of Isotopes Development. Isotope Technology Branch, AEC.
RADIATION APPLICATIONS AND FISSION PRODUCT UTILIZATION. A Bibliography of Selected Unclassified Literature. Gifford A. Young, comp. Jan. 1959. 187p. OTS.

The potential value of high-intensity nuclear radiation in chemical processing, in sterilization of foods and medical supplies, and as a unique energy source has continued to excite interest in development of practical applications and in production of high-energy gamma and beta irradiators. Numerous private industrial firms have initiated research programs to explore the potentialities of industrial radiation. The U. S. Atomic Energy Commission, keenly aware of the many technological and economic problems that must be solved before the full potential of nuclear radiation becomes a practical reality, is supporting basic and applied research on radiation phenomena, conducting programs of fission product separation and radiation source production, and surveying world technology and economic aspects of industrial applications. The U. S. Army Quartermaster Corps is continuing its active programs in radiation preservation of foods. The commercial appearance of several radiation-produced industrial products such as crosslinked polyethylene, permeaselective ion exchange membranes, and bondable and dye-accepting fluorocarbon plastics has lent encouragement to hopes for successful accomplishment of many radiation development program aims. Unclassified reports and published articles of interest to programs for practical utilization of fission products and high-intensity radiation which have appeared in Nuclear Science Abstracts from June 1, 1955, to December 31, 1958, are annotated in this bibliography. Pertinent individual papers presented at the 1955 Geneva Conference on the Peaceful Uses of Atomic Energy also have been included since these were not annotated individually in NSA. This supplement continues the bibliographic control of information originating in the Atomic Energy Commission and elsewhere on radiosterilization, radiation-induced chemical reactions, other uses of high-intensity radiation, and preparation and use of radiation sources begun by the preceding publications in this series, TID-3046 and TID-3046(Suppl. 1). 1360 references. (auth)

USES OF
- General (Surveys) 2.55.02

15170 A/CONF.15/P/2390
Atomic Energy Commission, Washington, D. C.
PROGRESS IN THE USE OF ISOTOPES. THE ATOMIC TRIAD—REACTORS, RADIOISOTOPES AND RADIATION. Willard F. Libby. 25p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

Recent years have seen a substantial growth in the use of isotopes in medicine, agriculture, and industry. Up to the minute information on the production and use of isotopes in the U.S. is presented. The application of radioisotopes to industrial processes and manufacturing operations has expanded more rapidly than any one except its most ardent advocates expected. New uses and new users are numerous. The adoption by industry of low level counting techniques which make possible the use of carbon-14 and tritium in the control of industrial processes and in certain exploratory and research problems is perhaps most promising of current developments. The latest information on savings to industry will be presented. The medical application of isotopes has continued to develop at a rapid pace. The current trend appears to be in the direction of improvements in technique and the substitution of more effective isotopes for those presently in use. Potential and actual benefits accruing from the use of isotopes in agriculture are reviewed. The various methods of production of radioisotopes are discussed. Not only the present methods but also interesting new possibilities are covered. Although isotopes are but one of the many peaceful uses of the atom, it is the first to pay its way. (auth)

10028
MACHINES GIVE CHEAPER RADIATION. C. H. Stockman and R. G. Bauman (B. E. Goodrich Co., Beckersville, Ohio). Chem. Eng. News 35, No. 31, 16-21(1957) Aug. 5.

Proposed commercial applications of γ radiation in the production of benzene hexachloride and nitric acid; in the sterilization of food, drugs, antibiotics, hormones, and tissue transplant materials; as a chemical polymerization catalyst; and in the vulcanization of rubber and other elastomers are discussed. Efficiency and costs of irradiation machines are compared with γ radiation from isotopes. Present prices and possible future prices are considered. It is concluded that isotopes will be too costly for wide use in radiation processing until spent nuclear fuel sources are available, and that machine radiation is the cheapest source available at present. (C.H.)

383
A SELECTED READING LIST OF USES OF ISOTOPES AND APPLIED RADIATION. R. J. Millett, comp. Intern. J. Appl. Radiation Isotopes 2, 287-94(1957).

The list comprises references to books and review articles only (with some reports and bibliographies). The references are taken from the published literature for the period 1950–1957 and are set out in each section in date order starting with the latest reference. No attempt has been made to cover the literature on methods of detection, dosimetry and health hazards, and radiobiology and genetic effects. (auth)

11016 AEC-tr-2925
ALL-UNION CONFERENCE ON THE APPLICATION OF RADIOACTIVE AND STABLE ISOTOPES IN THE NATIONAL ECONOMY AND SCIENCE. (ABSTRACTS OF PAPERS AND PLENARY SESSION PAPERS). Translated from a publication of the Academy of Sciences U.S.S.R., Moscow, 1957. 460p. $2.20(OTS).

Abstracts are presented of papers presented at a conference on applications of stable and radioactive isotopes in the national economy and science in the U.S.S.R. Topics discussed include: isotope production and high-intensity γ systems; industrial and technical uses of isotopes; uses of isotopes in biology, medicine, and agriculture; and radiation chemistry. Papers included in their entirety cover the following topics; applications of radioactive methods in prospecting and developing useful minerals; the use of nuclear radiation for automation and technological process control; the effects of small radiation doses on living organisms; the use of radioactive isotopes in clinical medicine; and applications of isotopes and radiations in agronomy. (C.H.)

4527 CEA-tr-R495
UTILISATION DES RADIOISOTOPES EN U.R.S.S. (Utilization of Radioisotopes in the U.S.S.R.) G. V. Kourdioumov, M. B. Neimane, and G. H. Frank. Translated from Atomnaya Energ. 3, 465-78(1957). 43p.

A review is presented of the uses of radioisotopes in the USSR. Uses in the fields of chemistry, biology and medicine, and agronomy are cited. 98 references.

USES OF
- General (Surveys) 2.55.02

4521 HW-57670
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
CONSIDERATION OF THE PRESENT AND FUTURE MARKET FOR CESIUM-137. L. E. Brownell. Aug. 29, 1958. 75p. Contract [W-31-109-Eng-52]. $12.30(ph OTS); $4.50(mf OTS).

One of the primary problems in the consideration of the present and future market for cesium-137 is the pricing of this radioisotope. Based on present and probable future prices of cesium-137 and cobalt-60 for applications in which either radioisotope may be used, it is believed that cobalt-60 will be preferred to cesium-137 if the sources are to be sold and written off in about 5 years or less. On a rental basis (using an AEC write-off in 30 years) cesium-137 will be preferred. Present markets for cesium-137 sources are believed to exist in the following applications: teletherapy, industrial radiography, hospital radiosterilization of surgical supplies, commercial radiosterilization of bulk medical supplies, commercial sterilization of pharmaceuticals and medical specialties, promotion of chemical reactions, and research sources. A summary of the estimates of the present (1959) market for cesium-137 with the minimum and maximum curiages involved and with comments regarding the various applications is given. It is expected that these markets can be realized only as a result of aggressive promotion both by AEC and industry of cesium-137 and associated machines and equipment for using cesium-137. A large future market for cesium-137 is believed to exist primarily in the field of food processing with gamma radiation. Before this market becomes a reality the Food and Drug Administration must approve the use of gamma radiation as means of commercial processing of foods. Since sources for such applications will be in the multimegacurie range, the costs for the sources will be large, and the pricing of cesium-137 will be a most important consideration. It is believed that this market will develop by 1961. A summary of the estimates of future (1962) market for cesium-137 is given. (auth)

16873
APPLIED RADIATION. Nucleonics 16, No. 9, 86-91 (1958) Sept.

The papers presented at Geneva on applied radiation discussed new labeling techniques, nuclide production, tracing technology, radiation sources, radiation effects, and food preservation. (J.S.R.)

CHERENKOV RADIATION AND ITS PRACTICAL APPLICATIONS—A BIBLIOGRAPHY. B. J. Wilson. Dec. 1958. 13p. $0.35(BIS).

This bibliography consists mainly of references to articles and reports which have appeared since December 1956 and is intended to supplement AERE Inf/Bib 90 and Inf/Bib 90 Supplement 1. The bibliography includes major references to the literature on Cherenkov radiation, counters, and detectors. (J.E.D.)

13648 TID-3076
Technical Information Service Extension, AEC.
ISOTOPES: BIBLIOGRAPHY OF UNITED STATES RESEARCH AND APPLICATION—1955-1957. J. A. McCormick, comp. May 1958. 267p. $2.25(OTS).

A bibliography as a guide to the technical aspects of isotope research and application is presented. Nearly 600 references are categorized into 30 fields of work with radioactive and stable isotopes. The bibliography is restricted to published literature references. Unclassified and declassified reports written by investigators working in AEC laboratories, but not published in open literature are not included. An author index and a key to journal abbreviations are included. Reference titles are listed alphabetically within the categories of isotope uses. (J.E.D.)

THE ISOTOPE INDEX; the Complete Purchasing Guide to the Isotopes. Scientific Equipment Co. 3d ed. Indianapolis, 1958. $3.

Lists sources and prices of commercially available isotopes as of February 1, 1958.

7174
UTILIZATION OF RADIATION; INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY IN PRAGUE. G. Kratochvil. Jaderna Energie 4, No. 1, 28(1958) Jan. (In Czech.)

12108 NYO-4746
Massachusetts Inst. of Tech., Cambridge.
QUARTERLY PROGRESS REPORT FOR THE PERIOD JULY 1, 1957—SEPTEMBER 30, 1957. Bernard E. Proctor, Samuel A. Goldblith, and Philip M. Richardson. Sept. 30, 1957. 100p. Contract AT(30-1)-1952. $15.30 (ph OTS); $5.40(mf OTS).

A selected bibliography of radiation applications for the period July-Dec. 1956 is presented. Applications are grouped into physical effects, penetration of matter, biological effects, insect and fungus control, radiation chemistry, and isotopes. (For preceding period see NYO-4745.) (W.D.M.)

USES OF -GENERAL (Surveys) 2.55.02

6492 AERE-Inf/Bib-90(Suppl. 1)
Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.
CHERENKOV RADIATION AND ITS PRACTICAL APPLICATIONS. A BIBLIOGRAPHY. J. E. Terry. Dec. 1956. 19p.

ISOTOPES . . . An Eight-Year Summary of Distribution and Utilization With Bibliography. U. S. Atomic Energy Commission. Washington, Government Printing Office, 1955. 357 p. $2.50 (paper).

This is a résumé of isotope utilization during the first 8½ years of the U. S. Atomic Energy Commission's distribution program. It is also a supplement to *Isotopes; a 3-Year Summary of United States Distribution* (1949), and *Isotopes; a Five-Year Summary of Distribution, with Bibliography* (1951). Includes papers on: use of isotopes in medicine, biology, agriculture, industry, research; available materials and services; technical services and training opportunities. The bibliography comprises more than 7,000 recent open-literature references on work with radioactive and stable isotopes.

23001
STATEMENT OF BERNARD MANOWITZ, BROOKHAVEN NATIONAL LABORATORY, UPTON, N. Y. p.2324-35 of "Hearings on Industrial Radioactive Waste Disposal. Volume 3."

Potential use of fission products from waste disposal is evaluated in terms of application, markets, and economic feasibility. (C.J.G.)

5420
HANDBOOK OF RADIOISOTOPE APPLICATIONS. Jerome D. Luntz, ed. New York, Nucleonics. 144p. Price $1.00.

Topics discussed in this handbook include radiation sources; industrial applications; food sterilization; chemical uses of radioisotopes; uses of radioisotopes in biology, medicine, and agriculture; and applications of radioisotopes in studies in the fields of geology and metallurgy. (C.H.)

USES OF - INDUSTRY General (Surveys) 2.55.03.01

3477 TID-7557(p.65-74)
Office of Industrial Development, AEC.
GROWING INDUSTRIAL USES OF RADIOISOTOPES. Paul C. Aebersold. p.65-74 [of] FIFTH INTERNATIONAL CONGRESS AND EXHIBITION OF ELECTRONICS AND ATOMIC ENERGY, ROME, ITALY, JUNE 16-30, 1958. (U. S. Papers). 10p.

Radioisotope applications are well on the way to becoming the foremost peaceful use of our atomic technology. As tracers and in gauging, radioisotopes will have a significant effect on the world's industrial economy. Radioisotope-process-control techniques, coupled with electronic-data tabulation and automatic-control devices, will assist in the realization of the age of automation, with the consequent transfer of human hands and minds from routine to more productive and satisfying labor. As sources of high-level radiation, radioisotopes will increase the distribution of foodstuffs and the variety of industrial products, reducing want and increasing the world's standard of living. New industries will arise to supply and service devices using radioisotopes and to exploit new discoveries in radiation applications. Radioisotopes will contribute materially to the health, leisure, and welfare of all mankind. The United States, through many educational and technical assistance programs encompassed by its Atoms-for-Peace Program, will make every effort to bring about world-wide benefits from the atom. (auth)

INDUSTRIAL APPLICATION OF RADIOISOTOPES AND THEIR INDUSTRIAL IMPORTANCE. George Manov. Bull. Inform. Assoc. belge develop. pacifique energie atomique No. 16, 11-17(1958) Sept. (In French)

The article on the industrial application of radioisotopes is concluded with some examples of the use of radiation reflection and atom tracers. The application of radioisotopes to chemical analysis and control of chemical processes is discussed. The economic aspects of the utilization of radioactive isotopes are briefly surveyed. (J.S.R.)

USES OF - INDUSTRY
General (Surveys) 2.55.03.01

8862
INDUSTRIAL USES OF FISSION PRODUCTS. S. Jefferson. pp. 153-4 in (Disposal of Industrial Waste Materials. New York, The Macmillan Co., 1957. 158p).
A brief discussion of the uses of fission product radiation in initiating chemical reactions, producing physical changes, and sterilizing of food is presented. (T.R.H.)

7060
INDUSTRIAL USE OF RADIO-ISOTOPES. Alan B. Lillie. pp. 167-99 in "Proceeding of the Scientific Congress, Nuclear Sessions, July 2-6, 1956, 3rd. Electronic-Nuclear International Review." Rome, National Committee for Nuclear Research, 1956. 447p. (In Italian)
A survey of the industrial uses of radioisotopes is presented under the general classifications of radiation affecting material, materials affecting radiation are such applications as thickness and density measurements, controlling equipment, and level controls and indicators. In the category of radiation affecting materials is found radiation batteries, elimination of fire hazards by elimination of static electricity, sterilization and preservation, and activation of chemical processes. In the third category radiation is applied to chemical analysis and tracer studies. (J.S.R.)

11330
INDUSTRIAL UTILIZATION OF RADIOISOTOPES—1946-56. A Forum Survey. Edwin Wiggin and Elaine Gladstone, eds. New York, Atomic Industrial Forum, Inc., 1956. 129p. $2.50.
A survey is presented of all industrial organizations licensed by AEC from the beginning of the isotope distribution program to the cut-off date of the tabulation. It also includes details on all licenses issued except those of a company-confidential nature. (W. L. H.)

210
PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, HELD IN GENEVA, AUGUST 8-20, 1955. VOLUME 15. APPLICATIONS OF RADIOACTIVE ISOTOPES AND FISSION PRODUCTS IN RESEARCH AND INDUSTRY. New York, United Nations, 1956. 327p. $7.50.

INDUSTRIAL UTILIZATION OF RADIOISOTOPES, August 2, 1946—February 9, 1956. Atomic Industrial Forum. New York, 1956. 87 (42) p. $1.50.
Survey of organizations licensed by AEC indicating purpose of radioisotope application.

7802 NP-6653
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE INDUSTRIAL UTILISATION OF FISSION PRODUCTS. R. Roberts. [1955?]. 22p.
Industrial applications of fission products are reviewed. In addition to the economic aspects of salvaging uranium fission products the increasing problem of storage will be partially solved. It is estimated that by 1975, 18.5 tons of U^{235} will be used in power plants of Great Britian alone each year. This would mean an almost equal mass of depleted uranium which could be utilized in a recovery program. It is believed that sufficient experience has now been accumulated within the Atomic Energy Authority for workers to feel that no difficulty will be encountered in handling very large sources on an industrial scale. It is anticipated that the demand for these sources will increase and that there will be many possibilities for their use in industry. Part two of this article deals with some of these possibilities. (A.C.)

PRESENT STATE AND PROSPECTS OF THE UTILIZATION OF RADIOACTIVE ISOTOPES IN PROCESSING, TRANSPORTATION, STORAGE AND USE OF PETROLEUM AND PETROLEUM PRODUCTS. Yu. S. Zaslavskiy. Sbornik Primenen. radioakt. izot. i izluchen. v. neft. prom. Moscos. Gostoptekhizdat. 84-99 (1957). (Translated from Referat. Zhur. Khim. No. 1, 1958, Abstract No. 2514)

A review is presented on tracer techniques used in the petroleum industry. 13 references. (J.S.R.)

10081
THE INDUSTRIAL USE OF RADIOACTIVE MATERIALS. K. Hogrebe. Atomwirtschaft 3, 311-13(1958) Aug.-Sept. (In German)
The present state of development in the industrial use of radioactive materials and the progress made from 1955 to 1958 in the German Federal Republic are described. The annual turnover of radioisotopes increased from 372,000 to 682,000 DM during this period, although, as yet, there is no domestic production. Of the total of 510 users, there were 210 medical, 160 industrial, and 140 research institutes in 1957. (J.S.R.)

USES OF - INDUSTRY
General (Surveys) 2.55.03.01

13907
SYMPOSIUM ON RADIOISOTOPES. PRESENTED AT THE SECOND PACIFIC AREA NATIONAL MEETING, LOS ANGELES, CALIF., SEPTEMBER 21, 1956. ASTM Special Technical Publication No. 215. Philadelphia, American Society for Testing Materials, 1958. 96p. $2.75.

Papers, presented on testing techniques utilizing radioisotopes, demonstrated the wide range of industrial uses to which they are applicable. The articles were "Electroplating and Metal Preservation Studies Utilizing Radioisotopes," "Evaluation of Rubber Deterioration by Means of Phosphorus-32," "Autoradiography as a Testing Technique," "Use of Radioactive Tracers in the Study of Soil Removal and Detergency," "Refinery Scale Application of Radioactive Tracers," "Activation Analysis for Industry," "Thickness, Density, and Concentration Gaging with Radioisotopes," "Will ASTM Standards Be Influenced by Radiation Effects in Metals?," and "The Problem of Establishing Specification for Irradiated Organic Materials." (J.S.R.)

IRRADIATION FOR INDUSTRY. Nuclear Power 2, 492-518 (1957) Dec.

A collection of papers are presented on irradiation for industry. They include papers on what industry can do (now and in the future), types of radiation (characteristics and uses), machines for producing radiation (electrostatic generators and linear accelerators), radiation dosimetry (units and measurements), source irradiation units (isotope facilities), instruments for irradiation health, safety and control, the technology of ionizing radiations and how Harwell plans to develop, British gamma facilities and some irradiation sources, and British machine facilities and industrial units. (W.L.H.)

377 TID-3511
Technical Information Service Extension, AEC.
BIBLIOGRAPHY ON USES OF RADIOACTIVE AND STABLE ISOTOPES IN INDUSTRY. A List of Selected References. J. A. McCormick, comp. July 1957. 27p. $0.75(OTS).

This bibliography contains 455 references to articles from the open literature. An author index and literature reference source are also included. The main purpose is to indicate the information that is available on what has been and is being accomplished through the use of radioisotopes in industry. (auth)

385
RADIOISOTOPES. Willard F. Libby (U. S. Atomic Energy Commission). Nucleonics 15, No. 9, 118-21(1957) Sept.

Milestones in the distribution of radioisotopes by the Atomic Energy Commission during the past ten years are outlined. One-third of one percent of the industrial manufacturing and mining concerns in the United States at present utilize radioisotopes. Savings resulting from the use of radioisotopes amount to approximately one-half billion dollars a year. Rapid expansion in the use of radioisotopes is predicted due both to increased market penetration of already developed industrial applications, and the development of new applications for low-level tracing and high-level irradiation. (C.H.)

RADIOISOTOPES IN TECHNOLOGY: PRACTICAL APPLICATIONS OF ATOMIC ENERGY IN INDUSTRY (Radioisotopen in de Techniek: Praktische Toepassingen van Atoomenergie in de Bedrijven). T. Van Der Klis. Amsterdam, N. V. Uitgeversmaatschappij Diligentia, 1957. 151p. $4.25. (In Dutch)

The practical applications of radioisotopes in industry are reviewed. As an introduction the properties of radioisotopes and how to obtain them are discussed. A description is given of the instruments used for the detection and measurement of radiation. The use of gamma radiography in non-destructive materials testing is then described. Thickness, density, and level measurements form another industrial application. A brief survey is given of tracer techniques. Then the use of radioisotopes in the acceleration of chemical reactions, conservation of foods, direct production of electricity, and preparation of luminous paints is discussed. The final chapter concerns personnel protection. (J.S.R.)

NEW INCREASES OF PRODUCTIVITY BY NUCLEAR ENERGY. Jacques Errera. pp. 139-162 in "Atti del Congresso Scientifico. Volume I. Sezione Nucleare, Giugno 1957." (In French)

Economic changes caused by the industrial application of nuclear energy are briefly surveyed. Military applications, production of electric power, utilization of radioisotopes in industry, and agricultural applications are reviewed. (J.S.R.)

USES OF - INDUSTRY
General (Surveys) 2.55.03.01

5997 A/CONF.15/P/166
RECENT USES OF RADIOISOTOPES IN TECHNOLOGICAL RESEARCH AND CONTROL IN SWEDEN. Lars-G. Erwall and Knut Ljunggren (Kungl. Tekniska Högskolan, Stockholm). 27p.

A survey of recent industrial applications of tracer techniques in Sweden is presented. An account is given of some investigations made in the cellulose, peat, cement, sugar refining, and iron and steel industries. An analysis of the investigations reported shows that the solution of many technological problems depends more on physical labeling of a certain phase of material than on exact chemical identity. This affords a wider range of possibilities for the selection of the nuclide most attractive from the point of view of safety. (W.D.M.)

6043 A/CONF.15/P/2308
PRIMENENIE RADIOAKTIVNYKH IZOTOPOV V SSSR. (Production and Application of Radioactive Isotopes in the USSR.) A. V. Topchiev, I. T. Alad'ev, and P. S. Savitskii (Savitsky) (U.S.S.R.). 39p.

A survey of the production and application of radioisotopes in the U.S.S.R. is presented. The results of the use of radioisotopes in prospecting and production control and in metallurgical, chemical, textile, and food industries are emphasized. The economic efficiency of some isotopes is analyzed. New data which were obtained in various scientific fields where isotopes are used are presented. 89 references. (J.S.R.)

6454 A/CONF.15/P/1235
PRODUCTION ET UTILISATION DES RADIOELEMENTS ARTIFICIELS EN FRANCE. (Production and Use of Radioisotopes in France.) C. Fisher and L. Cassin (Commissariat à l'Énergie Atomique, Paris). 16p.

The French radioisotope production program is described in some detail. The increase in the use of radioisotopes in industry since the 1955 Geneva Conference is discussed. Although the isotope production does not yet meet the national demand, the production rate is increasing. (J.S.R.)

6012 A/CONF.15/P/1231
SOME NEW APPLICATIONS OF RADIO ELEMENTS IN FRANCE. P. Leveque, R. Hours, et al. (Commissariat à l'Energie Atomique, Paris). 23p.

Some applications of radioisotopes which have not been previously published are described. By measuring the transmission of a flat beam of thermal neutrons, the moisture content of a parallelepipedon-shaped soil sample can be measured to ±4% and the moisture gradient along the longitudinal axis determined. The method permits the determination of chemically bound water and the measurement of diffusion coefficients of water into low hydrogenated materials. By measuring the intensity of fluorescence excited by β radiation, it is possible to determine the thickness of metal coatings of less than 20 μ for metals of atomic number less than 40. This method was applied to chromium, manganese, iron, cobalt, nickel, copper, and zinc. By using a suitable metal filter, it is possible to measure coating thicknesses of metals differing by only one atomic number from the supporting material. By employing labeled cement, it is possible to determine the extent of movement of cement grout used for soil stabilization and impermeabilization. The kinetics of ion exchange of lapis lazuli in aqueous solutions was studied by tracing the movement of labeled ions in the solution or in the exchanger. Values of the diffusion coefficients and activation energies were determined from the exchange studies. (auth)

6425 A/CONF.15/P/65
SOME RECENT ADVANCES IN THE CHEMICAL UTILIZATION OF FISSION PRODUCTS. R. Roberts, F. L. Dalton, P. Hayden, and P. R. Hills (Atomic Energy Research Establishment, Harwell, Berks, Eng.). 19p.

The development of nuclear power programs has led to a study of reactions initiated by radiation which might be of industrial importance. Some of the work which has been carried out on polymerization and halogenation is described. The program of work in polymerization concerns the radiation-initiated polymerization of fluorocarbon olefins and a study of graft copolymerization. Halogenation studies are represented by work on the chlorination of benzene. (W.D.M.)

USES OF - INDUSTRY
General (Surveys) 2.55.03.01

10285

INDUSTRIAL USES OF RADIOISOTOPES. Studies in Business Policy, No. 87. New York, National Industrial Conference Board, Inc., 1958. 88p. $5.00.

Present industrial applications of radioisotopes are reviewed and possible future uses are discussed. Principal applications discussed include radioisotope gages for thickness gaging, density measurements, and indicating liquid levels; as sources for industrial radiography and inspection; tracer applications in wear and corrosion studies, flow and location determinations, chemical reactions studies, and chemical analysis; as ionization sources; in atomic batteries; as radiation sources for use in the sterilization of foods, drugs, and pharmaceuticals; in plant breeding; for the induction of chemical reactions; and as high intensity sources of radiation. The United States, Canadian, and United Kingdom radioisotope programs are discussed. (C.H.)

14635 A/CONF.15/P/1775

Argonne National Lab., Lemont, Ill.

THE RADIOACTIVE ISOTOPE F^{18}: PREPARATION, PROPERTIES AND USES. R. M. Adams, I. Sheft, and J. J. Katz. 10p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

The isotope F^{18} is produced in a betatron, cyclotron, or nuclear reactor using various nuclear reactions. Studies have been made using F^{18} in many chemical problems of fluorine compounds. The kinetics of the gas-phase exchanges between ClF_3, BrF_5, IF_7, and F_2 in the temperature range 200 to 300°C show that the ClF_3-F_2 and IF_7-F_2 exchanges may be interpreted on the basis of a homogeneous dissociative exchanges plus a heterogeneous exchange taking place on the NiF_2-coated surface of the exchange vessel. Isotopic exchange between solid inorganic fluorides and gaseous fluorocarbons has also been studied using F^{18}. Potential application of F^{18} to problems in analysis, industry, and fundamental and applied research is discussed. (J.E.D.)

PROCEEDINGS OF THE SECOND UNITED NATIONS INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, HELD IN GENEVA, 1 SEPTEMBER–13 SEPTEMBER 1958. VOLUME 19. THE USE OF ISOTOPES: INDUSTRIAL USE. Geneva, United Nations, 1958. 372p. $12.50.

More than fifty papers from nineteen different countries are included in this volume. The topics covered include function and wear studies, effect of additives on lubricants, measurement of piston wear in I-C engines, defect inspection by a two-counter method, control and measurement techniques, production and technique checks in the metal industries, flotation processes, continuous analysis of moving hydrocarbons, gamma-induced polymerization, and a total-count method of flow measurement. (W.D.M.)

6871 A/CONF.15/P/1321

UTILIZATION OF RADIOISOTOPES AND HIGH ENERGY RADIATION IN JAPAN. (Atomic Energy Bureau, Japan). 9p.

Since radioisotopes were imported into Japan for the first time from Oak Ridge National Laboratory in 1950, demands for radioisotopes for research uses have been increasing year after year. The remarkable increase is especially seen in I^{131}, P^{32}, and Au^{198}, and the amounts of their monthly imports are roughly 3,200 mc, 2,500 mc, and 1,800 mc, respectively. The import of Co^{60} as a gamma irradiation source amounted to only 443 curies in 1954, but more than 20,000 curies are expected to be imported in 1958. The number of research projects using radioisotopes was only 139 in 1950, but it amounted to about 3,000 projects in 1956 and is expected to increase to more than 4,000 in 1957. The classification of the research projects made according to the field in which radioisotopes are used shows that 60% of radioisotopes are used in medical science and the rest for physics, chemistry, biology, agriculture, and industry. In medical science, the materials are mostly used for diagnosis and therapy and some of them for research on metabolism, effects of various radiations on the function of organs, blood circulation, and others. (auth)

USES OF - INDUSTRY
General (Surveys) 2.55.03.01

14645 A/CONF.15/P/795
Esso Research and Engineering Co., Linden, N. J.
THE USE OF NUCLEAR RADIATION IN CHEMICAL PROCESSING OPERATIONS. Frank T. Barr, H. J. Ogorzaly, and T. A. Teiter. 9p. $0.50(OTS).

A review of radiation sources and methods for process applications is presented, including observations on limitations and economics. Sources of radiation for promotion of chemical reactions include radioisotopes, accelerators, and nuclear reactors. Radioisotopes may be either fission products or materials activated in a reactor; they supply gamma radiation. Accelerators provide high energy electrons under more controllable conditions. Reactors can provide gamma, neutron, and recoil fission product radiation. Design studies for reactors supplying radiation to process streams passing directly through the core indicate that they are feasible and can be made safe. Another use of reactors is in supplying process heat. Because there is no flue gas to limit efficiency in the supply of high temperature heat from reactors, it is in this field that nuclear heating may be most attractive. The primary limitation is in materials of construction. Supply to the process stream may be either direct or through an intermediate agent. Nuclear reactors may also be used to supply process steam. A survey of possible systems for the practical utilization of nuclear energy in the process industries is included. Joint supply of radiation and heat, radiation and power, and of process heat, steam, and power is considered. (auth)

14760 A/CONF.15/P/819
General Electric Co. General Engineering Lab., Schenectady, N. Y.
THE USE OF ACTIVATION IN MAKING ISOTOPE TECHNIQUES MORE AVAILABLE TO INDUSTRY. W. W. Schultz, H. D. Briggs, R. A. Dewes, E. E. Goodale, D. H. Morley, J. P. Neissel, R. S. Rochlin, and V. V. Verbinski. 26p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

The industrial applications of the activation technique described include: the measurement of gear wear by activating wear particles in the lubricant, activation autoradiography, flow measurement by activation, die wear measurement by activation, induced line sources for position measurement, and activation in the foundry. (M.H.R.)

USES OF - INDUSTRY
General (Surveys) 2.55.03.01

Industrial Uses of Atomic Waste, F. C. Livvingstone. Plant Eng. 11, 8, Aug 1957, 95-7, 198.

British solution for disposal of spent but still intensely radioactive fuel elements at Calder Hall atomic power station, found in marketing thulium 170, cobalt 60, and caesium 137 as sources for gamma radiography; techniques and equipment developed by Nuclear Engineering for inspection of castings, welds, etc.

USES OF - INDUSTRY
Power 2.55.03.02

1182 MND-SR-1674
Martin Co. Nuclear Div., Baltimore.
STRONTIUM 90 POWER PROJECT. Quarterly Progress Report III covering period April 15, 1959 through July 15, 1959. July 1959. 79p. Contract AT(30-1)-2220, Task II. OTS.

As a result of information received from ORNL, early strontium titanate heat elements may contain macro quantities of stable Ca and Ba. Since these contaminants could affect the solubility of strontium titanate to the detriment of safe containment, test heat elements were prepared containing varying amounts of these elements. In addition to solubility measurements in fresh and sea water, samples are being examined to determine the physical properties of this new mixture. The ceramic investigation showed that heat elements made from pure strontium titanate would be superior to any cermet of that compound. Metal additions below 30 wt. % had no effect on thermal conductivity and did, in some cases, increase the solubility of the heat element by forming soluble complex compounds with the otherwise in-

soluble strontium titanate. The process for fabricating strontium titanate heat element increments was refined to produce uniform pellets of optimal density, homogeneity, and Sr tie up. To assure future availability of pure Sr^{90} in kilocurie quantities, the separation of this waste fission product is under laboratory scale investigation by ion exchange. Data compiled on the physical and chemical properties of strontium titanate are completed. Results indicate that this choice of heat element compound will possess those properties required for the safe utilization of a Sr^{90} heat source. The thermal conductivity of this compound decreases only slightly with increased temperature, thereby assuring a generator core that will not melt on accidental temperature excursion. The solubility of strontium titanate in fresh and sea water was measured over a period of 100 days. At the end of this time there was absolutely no strontium detectable in the fresh water and only 10 ppb in the sea water. Such information indicates that unclad strontium titanate heat elements would require centuries to dissolve, during which time natural radioactive decay would have reduced kilocurie quantities of Sr^{90} to the millicurie level. A modified sea design with a removable biological shield will make possible the use of this power supply in marine environments where weight is a critical factor. This unit will employ less Sr^{90} with longer thermocouples. The operational shell will be of sufficient thickness to be resistant to deep sea pressure. During storage, it will be encased in a second nickel shield with a liquid metal film between to act as a heat transfer agent. It is anticipated that both sea application devices will operate at approximately seven percent efficiency. Hazards evaluation of the land-based application is in progress. Both structural and radiation integrity are being evaluated. Data obtained during the experimental phases have been interpreted to determine the resistance of a Sr^{90} generator to natural and man-made disasters. (For preceding period see MND-SR-1673.) (auth)

14473 A/CONF.15/P/833
Martin Co., Baltimore.
POWER FROM RADIOISOTOPES. Kenneth P. Johnson. 14p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

The use of radioisotopes as a source of power is discussed. Two power ranges, ten and 500 watts, are explored. The selection of fuel is determined by power density in realizable form, cost, availability, shielding, and biological hazards considerations. A list of feasible radioisotopes is presented based on the above considerations. These radioisotope fuels are divided into the two categories of reactor produced and fission products. Particular emphasis is placed on practical engineering problems to be considered in fuel selection such as minimization of biological hazards and radiological shielding requirements. Fuel element design and fabrication is discussed to illustrate realizable fuel forms and manufacturing techniques which might be employed. Radioisotope availability at the present time is a major consideration in view of the limited number of radioisotope separation and handling facilities. Future possibilities in the area of cost and availability are explored in the light of rising demand for radioisotope fuels. Power conversion systems are discussed with respect to the two levels of power being explored. (auth)

6455
ECONOMIC FUTURE OF FISSION PRODUCTS FOR RADIATION POWER. B. Manowitz and D. M. Richman (Brookhave National Lab., Upton, N. Y.). Nucleonics 14, No. 6, 98-102(1956) June.

An evaluation of the possibilities of obtaining income from fission products from the business of reprocessing spent reactor-fuel element is given. (F.S.)

USES OF - INDUSTRY
Power 2.55.03.02

A METHOD OF PRODUCING POWER FROM BETA-ACTIVE ISOTOPES. G. I. Rukman, V. P. Tychinskii, Ya. A. Yukhvidin. Trudy Nauch. Issledovatel'. Inst. Ministerstva Radiotekh. Prom. S.S.S.R., No. 6, 3-8 (1956). (Translated from Referat. Zhur. Elektrotekh., No. 2, 1958, p.118).

An atomic power source is suggested, based on the charge accumulation created by β-radiation in an electric capacitor. A charged capacitor is periodically discharged by a switching device onto an impulse transformer, the secondary winding of which supplies a load. A scheme of an atomic battery is also presented, its power and efficiency are calculated on the basis of a 10^5 curie β-source activity, with an average β-particle energy of 100-kev, and a 100-$\mu\mu$f capacitor, the optimum charging time that corresponds to the maximum efficiency (20.5%) is 20 microseconds, the capacitor voltage is 70 kv, and the mean output power is 13 w. With a 10:1 transformer ratio, the equivalent battery resistance is on the order of hundreds of ohms. The S^{35} sulfur isotope, with an average energy of about 100 kev and a half-life of 87.1 days, is recommended as a source of β-radiation.

USES OF - INDUSTRY
Processing 2.55.03.03

NUCLEAR RADIATION IN FOOD AND AGRICULTURE. W. Ralph Singleton, ed. Princeton, N. J., D. Van Nostrand Company, Inc., 1958. 387p.

The chapters in this book are based on papers selected from those presented at the Conference on Peaceful Uses of Atomic Energy held in Geneva. Switzerland. in August 1955. Selection was exercised not only in the individual papers chosen but also in the topics. Topics covered include: the general use of radioisotopes in agriculture; the biosynthesis of carbon-14-labeled plants; photosynthesis; plant physiology, pathology, and cytology; the stimulation of plant growth with ionizing radiation; root grafting; foliar absorption by plants; the uptake of minerals; tracing fungicidal actions; the effects of continuous gamma exposure on plant growth; cytological and chemical effects of radiation in plants; the use of radioisotopes in soil and fertilizer studies; genetic and biological hazards of nuclear radiation; the eradication of the screw-worm fly in the island of Curacao by the use of ionizing radiation; uses of radiation in plant breeding programs; and applications of radiation in food sterilization and preservation. 504 references. (C.H.)

USES OF - INDUSTRY
Processing 2.55.03.03

THE POTENTIAL CONTRIBUTION OF ATOMIC ENERGY TO DEVELOPMENT IN AGRICULTURE AND RELATED INDUSTRIES. R. A. Silow (Food and Agriculture Organization of the United Nations, Rome). Intern. J. Appl. Radiation and Isotopes 3, 257-80(1958) Aug.

Potential contributions of atomic energy to agriculture and food production are surveyed. Topics discussed include direct applications of atomic energy for power production, food preservation and processing, and in plant breeding programs. Applications of radioisotopes in agricultural research and in related fields such as soil fertility and crop nutrition investigations, crop production research, livestock production research, fisheries research, and human nutrition research are reviewed. (C.H.)

10497

SOME APPLICATION OF RADIOISOTOPES TO THE PETROLEUM INDUSTRY. A. Scaroni (CISE, Milan). Energia nucleare (Milan) 5, 297-306(1958) May. (In Italian)

Some of the main applications of radioisotopes to the petroleum industry are reported. In particular a review is given of laboratory research works, tests of special materials, well logging, drilling procedures, and plant operation controls which are of particular interest owing to their large and practical applications. Data are also reported concerning radiation effects on thermal cracking operations. (auth)

16128

RADIATION PRESERVATION OF FOODS. R. S. Hannan. Roy. Soc. Health 77, 457-65(1957) Aug.

Present trends in Great Britain in the radiation preservation of foods are reviewed. (C.H.)

10023

NEW FACILITIES, EXTENSIVE STUDY LEAD WAY TO RADIATION PROCESSING OF PETROLEUM. Chem. Eng. Progr. 53, 118, 120, 122(1957) July.

A report is presented on the growing importance being given radiation processing techniques by petroleum refiners and progress in the application of nuclear radiation to chemical processing. (auth)

USES OF - INDUSTRY (Processing) 2.55.03.03

4235
RADIATION PROCESSING OF FOODS. R. H. Wasserman (Oak Ridge Inst. of Nuclear Studies, Tenn.). J. Am. Dietet. Assoc. 33, 33-6(1957) Jan.
Recent advances in the processing of foods by exposure to ionizing radiations are reviewed. (C.H.)

17023
USE OF RADIOACTIVE ISOTOPES IN THE PROCESSING OF PETROLEUM. T. Filotti. Petrol. si gaze 8, No. 4, 198-204(1957). (Translated from Referat. Zhur. Khim. No. 1, 1958, Abstract No. 2515)
A survey is presented of the possibilities of utilizing radioactive isotopes in studying the flow of liquids at petroleum processing plants, measuring the volume of liquids in containers, and in treatment process control.

APPLICATION OF RADIOACTIVE ISOTOPES IN THE GAS INDUSTRY. Falentsky. Gaz Woda i Tech. Sanit. 31, No. 12, 465-7(1957). (Translated from Referat. Zhur. Khim. No. 16, 1958, Abstract No. 55176.)
A survey is made of the application of radioisotopes in the gas industry and the coke industry. 16 references

1162 COO-210
Michigan. Univ., Ann Arbor. Engineering Research Inst.
HIGH RADIOPASTEURIZATION AS A "NEW" FOOD PROCESS. L. E. Brownell and S. N. Purohit. Oct. 1955. 42p. Contract AT(11-1)-162. (ERI-1943-7-51-P)
A process called radiopasteurization, in which high γ radiation is combined with refrigeration, is proposed to increase the storage life of cooked meats, blanched vegetables, and food items packaged in plastic bags. Various types of food poisoning caused by microorganisms and their toxins are reviewed, and their control by radiopasteurization is discussed. Design features of a high-radiopasteurization γ facility, utilizing mixed fission products or packaged Cs^{137} as the source, are described. The proposed plant would be capable of processing about two tons per hour with two eight-hour shifts per day for 260 days per year, and could irradiate foods with a high-radiopasteurization dose of one megarep at an estimated cost of about one cent per pound. This cost is considered to be in the range of commercial feasibility. (C.H.)

USES OF - INDUSTRY (Tests and Measurements) 2.55.03.04

INDUSTRIAL APPLICATION OF RADIOISOTOPES AND THEIR ECONOMIC IMPORTANCE. George Manov. Bull. Inform. Assoc. belge develop. pacifique energie atomique No. 15, 15-18(1958) July. (In French)
The first part of an article on the industrial applications of radioisotopes is presented. The use of radioisotopes for radiography, thickness measurements, and density measurements is discussed. (J.S.R.)

16869
APPLICATION OF RADIOISOTOPES IN IRRADIATION TESTING OF MATERIALS. Wolfgang Kolb. Atombrief 4, 288-95(1958). (In German).
As an introduction, testing techniques and financial aspects of radiation testing are described. The methods and apparatus used for this work are discussed. The use of gamma radiation in many industries is illustrated. (J.S.R.)

2250
TECHNICAL APPLICATION OF RADIOISOTOPES IN GERMANY. E. Pohland, and K. Frenzen. Atomwirtschaft 4, 415-26(1959) Oct. (In German)
The technical application of radioactive isotopes is only just beginning in Germany. Nevertheless sealed sources are installed for production control in over one thousand thickness gages, in about four hundred filling-level indicators, and in density measuring equipment and for use in the non-destructive testing of materials. Practical examples are given of special technical processes which have been realized and of the application of open sources in technology. (auth)

MEASUREMENT OF THICKNESSES IN INDUSTRY BY BETA GAGE. C. Gagne. Industries Atomiques No. 7 and 8, 89-94(1957) June-July. (In French)
The use of radioisotopes in thickness gages in French industry is described. The operation, function, and capabilities of these instruments are discussed. (T.R.H.)

9181
C^{14} TRACER MEASURES FUEL DISTRIBUTION. Douglas E. Cooper (Ethyl Corporation Research Labs., Ferndale, Mich.). Nucleonics 15, No. 6, 136-40(1957) June.
The technique for radio tracer study of the distribution of gasoline additives (tetraethyl lead, tricresyl phosphate, etc.) in internal combustion engine intake systems is described. (T.R.H.)

USES OF - INDUSTRY
(Tests and Measurements) 2.55.03.04

17554 CWR-468
Curtiss-Wright Corp. Research Div., Quehanna, Penna.
A RADIOISOTOPE TACHOMETER. J. K. Kelly, N. E. Figurel, A. E. Heiges, and J. A. Curll. Apr. 30, 1957. 43p.

The results tabulated demonstrate the soundness of radioisotope tachometry as a method of measuring speed and direction of rotation. The tachometer was designed, built, and given thorough laboratory tests. These tests indicate that an accuracy of about 1% can be expected up to the maximum speed tested (17,600 rpm). It is further indicated that this system is accurate to much higher speeds. By simulating the scintillator signal with a sine wave, accurate counting was obtained beyond 50,000 counts per minute. However, since the limit of the mechanical test equipment prevented testing above 17,600 rpm with the radioisotope, experimental proof of the above statement was not possible. If an application for this tachometer is found for speeds in excess of 20,000 rpm, it may become necessary to increase the source strength to maintain the desired statistical accuracy. (auth)

5375
KRYPTON-85 SOURCE IMPROVES INDUSTRIAL THICKNESS GAGES. W. Everett Swift (Foxboro Co., Mass.). Nucleonics 15, No. 3, 66-7(1957) March.

The advantages of Kr^{85} sources over two other sources for use in industrial thickness gages are presented. (W.L.H.)

11908
MAKING USE OF THE ACHIEVEMENTS OF NUCLEAR PHYSICS IN METALLURGY. P. L. Gruzin. Primenenie Radioaktiv. Izotopov v Chernoi Met. 19-31(1957). (Translated from Referat. Zhur. Met. No. 4, 1958, p.1.)

The use of isotopes and nuclear radiations in metallurgy, instrument and machine manufacture, and the study and control of metallurgical processes is described.

9397
THE APPLICATION OF CESIUM-134 TO INDUSTRIAL RADIOGRAPHY. James W. Dutli and Dana E. Elliott (Los Alamos Scientific Lab., N. Mex.). Non-Destructive Testing 14, No. 2, 24-7(1956) Mar.-Apr.

4768
CAESIUM-137 FOR INDUSTRIAL RADIOGRAPHY. R. S. Morgan (Armament Research and Development Establishment, London). Brit. J. Appl. Phys. 7, 25-8(1956) Jan.

The suitability of Cs^{137} as a γ-ray emitter for the radiography of steel has been investigated. An exposure chart has been produced and penetrameter-sensitivities calculated from experimentally determined broad-beam and narrow-beam absorption curves. The broad-beam curve is approximately linear for steel thicknesses exceeding 0·8 in., and from its slope, it would be expected that Cs^{137} would give radiographs similar in contrast to an X-ray tube operating at about 1·25 million volts peak. While Cs^{137} is a useful source for the examination of steel in the thickness range 1·5 to 4·0 in., below 1·5 in. Ir^{192} is superior. Within the range 1·5 to 3·0 in. the penetrameter sensitivity obtainable with Cs^{137} reaches its optimum value and is better than that obtainable with either Ir^{192} or Co^{60}. Protection data for sources of various strengths have been calculated from an experimentally determined attenuation curve for Pb. (auth)

10064 NP-tr-225
THE USE OF RADIOACTIVE ISOTOPES IN METALLURGY. (Primeneniye Radioaktivnykh Izotopov v Metallurgiy.) I. S. Kulikov and I. A. Popov—N. V. Agreyev and V. F. Smirnov, eds. Translation of a publication from State Scientific and Technical Publishing House for Literature on Ferrous and Nonferrous Metallurgy, Moscow, 1956. 330p.

The principles of radioactivity are reviewed, and radioactive isotope applications in the metallurgy of iron and steel are considered. Reference material for calculations related to radioactive measurements are included in the appendix. The book is intended for use as a metallurgical reference useful to those using radioactive isotopes in investigations, and to higher metallurgical schools. 132 references. (J.R.D.)

375 AERE-I/R-2216
Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.
THE EXTRACTION, PURIFICATION AND INDUSTRIAL USES OF KRYPTON-85. E. J. Wilson, C. Evans, J. Chadwick, J. Eakins, and K. J. Taylor. Apr. 25, 1955. Decl. with amendments Dec. 28, 1956. 18p.

A method of purification, extraction, and measurement of Kr^{85} on the curie scale is described. Potential industrial uses of the isotope are also discussed. (auth)

4449 ARE-50/54
Gt. Brit. Armament Research Establishment, Seven Oaks, Kent, England.
THE USE OF CAESIUM-137 FOR INDUSTRIAL RADIOGRAPHY. R. S. Morgan. Aug. 1955. 18p. (AD-60859).

This report deals with the suitability of Cs^{137} as a gamma-ray emitter for the radiography of steel. An exposure-chart has been produced and penetrameter-sensitivities calculated from experimentally determined broad-beam and narrow-beam absorption curves. The broad-beam curve is approximately linear for steel thicknesses exceeding 0.8 in., and from its slope, it would be expected that Cs^{137} would give radiographs similar in contrast to an x-ray tube operating at about 1.25 million volts peak. Caesium gamma radiation is thus intermediate in quality between iridium and cobalt radiation and this has been confirmed radiographically. While it is a useful source for the examination of steel in the thickness range 1.5 to 4.0 in., below 1.5 in. Ir^{192} is superior, and above 4.0 in. Co^{60} gives better quality radiographs and is essential for penetration. Within the range 1.5 to 3.0 in., where its penetrameter sensitivity reaches its maximum value, Cs^{137} surpasses both Ir^{192} and Co^{60}. Protection data for sources of various strengths have been calculated from an

6039 A/CONF.15/P/2235
ISOTOPY Tu^{170}, Eu^{155}, I Ce^{144} KAK ISTOCHNIKI ISLUCHENIYA DLYA KONTROLYA TONKOSTENNYKH ISDELII. (Tm^{170}, Eu^{165},and Ce^{144} Isotopes as Radiation Sources for Controlling Thin-walled Wares.) S. V. Rumyantsev and L. N. Matsyuk (U.S.S.R.). 20p.

The physical properties of Tm^{170}, Eu^{155}, and Ce^{144} and the chief problems relating to their use for controlling thin-walled wares are discussed. The ionization constants of the isotopes studied are given as well as data characterizing self-absorption of the radiations in the sources and their attenuation on passing through metals. Because of self-absorption of the radiations, increasing the activity of the preparations (with constant specific activity) changes the radiation intensity per unit activity, as well as the spectral composition of the isotope radiations. (auth)

6033
SOME ASPECTS OF THE USE OF FISSION PRODUCT CAESIUM 137 IN TELECURIE UNITS. J. H. Mellink. J. belge radiol. 38, No. 4, 662-79(1955). (In English).

PROGRESS IN NUCLEAR ENERGY. SERIES VII. MEDICAL SCIENCES. VOLUME 2. Edited Proceedings of the Second International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958.
J. C. Bugher, J. Coursaget, and J. F. Loutit, eds. New York, Pergamon Press, 1959. 307p. $15.00.

Recent advances in the uses of radioactive isotopes in medicine are reviewed. Both diagnostic and therapeutic applications are discussed. Other topics discussed include dosimetry, health and safety procedures, radiological protection of workers engaged in the manufacture of natural uranium fuel, an evaluation of inhalation hazards in nuclear energy industry, developments in neutron capture therapy, radioinduced tumors, radiostrontium metabolism and decontamination in man, the detection of strontium-90 and cesium-137 in the human, new developments in radiation protection and recovery, the treatment and prophylaxis of radiation disease with leukocyte and thrombocyte masses, and biological and medical studies with high energy particle accelerators. Papers are included from a symposium on progress in teletherapy. (C.H.)

ADVANCES IN THE USE OF RADIOISOTOPES. MEDICAL USES. W. S. Eastwood. Nature 182, 1407-9(1958) Nov. 22.

Recent developments in the medical and general uses of radioisotopes that were presented at the 2nd Geneva Conference are reviewed. Discussions are included on: the use of tritium in biochemical work; applications to the central nervous system; the use of P^{32}, Ca^{45}, and S^{35} following the metabolic processes of healing fractures; radioiodine uses; diagnostic uses; therapeutic uses; and other isotope applications. (J.H.M.)

RECENT EXPERIMENTAL CONTRIBUTIONS TO RADIOTHERAPY. Henry S. Kaplan (Stanford Univ. School of Medicine, San Francisco). Am. J. Roentgenol. Radium Therapy Nuclear Med. 80, 822-32(1958) Nov.

Recent concepts of tissue radiation response are reviewed. Studies are discussed which cover effects elicited by radiation events occurring within the cells, tissue responses mediated by radiation effects in the environment, and effects related to the nature and mode of application of the agent. Applications in the field of clinical radiotherapy are stressed. 99 references. (C.H.)

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PROCEEDINGS OF THE SECOND UNITED NATIONS INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, HELD IN GENEVA, 1 SEPTEMBER–13 SEPTEMBER 1958. VOLUME 24. ISOTOPES IN BIOCHEMISTRY AND PHYSIOLOGY, PART 1. Geneva, United Nations, 1958. 302p. $11.00.

Recent developments in the use of radioactive isotopes in studies in the field of biochemistry and physiology are reviewed. Topics discussed include applications in studies on photosynthesis, cellular metabolism, ion transport, mineral metabolism, tracer studies on the fate and metabolism of drugs in the body, and the development of new techniques using radioisotopes as indicators in quantitative staining reactions, in the quantitative chromatography of fatty acids, activation analysis of biological materials, and applications of the nuclear reactor in biochemical analysis and neutron activation chromatography. (C.H.)

1046 TID-3514
Technical Information Service Extension, AEC.
RADIOISOTOPES IN MEDICINE AND HUMAN PHYSIOLOGY. A Selected List of References. J. A. McCormick, comp. Aug. 1958. 124p. $2.75(OTS).

This bibliography contains 2862 references on uses of radioisotopes in diagnostic medicine, therapeutic medicine, clinical research, human physiology, general medical research, and immunology. The references were taken from the 1948 to 1956 open literature. A list of the journals from which the references were selected and an author index are included. (auth)

NEW METHODS OF IONIZING RADIATION DOSIMETRY. M. N. D'yachenko (Kharkov Inst. of Medical Radiology). Med. Radiol. 3, No. 4, 75-8(1958) July-Aug. (In Russian)

The relation between scintillator luminescence intensity and the hardness and length of x- and γ-ray waves was investigated, and the practicability of application of scintillators in dosimetry is discussed. The design is presented of a luminescence dosimeter consisting of a stilbene crystal and photomultiplier. (R.V.J.)

11279
THE BASIS OF THERAPY WITH RADIOACTIVE ISOTOPES. Marshall Brucer (Oak Ridge Inst. of Nuclear Studies, Tenn.). Atomkern-Energie 3, 217-21(1958) June. (In German)

Radioisotopes are used today in widely dissimilar fields of medicine and in a widely varying manner. This chapter is an attempt to illustrate some basic principles of their use which are strongly related to the principles of radiation physics. The first part of the paper deals with the use of Co^{60}, Cs^{137}, and Eu^{155} for teletherapy machines and of Co^{60}, Eu^{152}, P^{32}, and Y^{90} for varying brachytherapy devices. The arising problems of radiation protection are also discussed. Following this, the use of isotopes in therapy by mechanical placement of the material will be described. This includes direct and intracavitary injection of Au^{198}, Y^{90}, and Lu^{177}. The following part shows the development of a new and promising type of therapy, called semimechanical placement. Here the isotope is not expected to remain at the place of injection but to be picked up by the lymphatic stream and be carried to the lymph nodes. Another variation is the intravenous injection of particulate matter which will be trapped in liver, spleen or bone marrow for internal irradiation. The final part is assigned to the metabolic location of isotopes, especially of I^{131}. The major problem is the dosage control. Emphasis is put on the recent developments of measuring devices, especially the scanning method and its correct evaluation for diagnostic purposes. (auth)

OUTLINE OF PROBABLE WORLD REQUIREMENTS OF COBALT 60 FOR THERAPY MACHINES. R. F. Errington (Atomic Energy of Canada, Ltd.). Radiology 70, 481-5 (1958) Apr.

14618 A/CONF.15/P/841
Brookhaven National Lab., Upton, N. Y.
APPLICATION OF ACTIVATION ANALYSIS TO BIOLOGICAL AND MEDICAL RESEARCH. Donald C. Borg. 14p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

The advantages, limitations, and scope of application of activation analysis in biology and medicine are discussed. An example given in some detail is that of Mn^{56} in tissue. (T.R.H.)

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14541 A/CONF.15/P/828
Picker X-Ray Corp. Picker Research Center, Cleveland and Michigan. Univ., Ann Arbor. Fission Products Lab.
STUDIES ON X-RAYS AND BREMSSTRAHLEN FROM SOURCE-TARGET MIXTURE. E. W. Coleman, L. E. Brownell, and C. J. Fox. 10p. $0.50(OTS).
Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.
Homogeneous mixtures of beta-emitting radioisotopes with stable target materials were investigated as possible radiation sources for medical radiography. Mixtures containing Ca^{45}, Tl^{204}, or Pm^{147} as chemical compounds have been prepared and their spectra determined. Radiographic testing of these sources indicates that Pm^{147}, or other low-energy beta emitters, show promise for use as medical x-ray sources. (auth)

11278
A FEW NOTIONS INVOLVED IN THE CLINICAL USE OF RADIOISOTOPES. Gould A. Andrews (Oak Ridge Inst. of Nuclear Studies, Tenn.). Ann. Internal Med. 47, No. 5, 922-38(1957) Nov.
Basic concepts in diagnostic and therapeutic applications of radioisotopes are reviewed. (C.H.)

THE IMPORTANCE OF RADIO ISOTOPE RESEARCH IN MEDICINE AND BIOLOGY. Georg v. Hevesy. Strahlentherapie 102, 341-54(1957) Mar. (In German)

CLINICAL USE OF RADIOISOTOPES. William H. Beierewaltes, Philip C. Johnson, and Arthur J. Solari. Philadelphia, W. B. Saunders Company, 1957. 469p.

4678
ISOTOPE MANUAL FOR THE PHYSICIAN. AN INTRODUCTION TO THE MEDICAL APPLICATION OF ISOTOPES. Walter Beier and Erich Dorner. Leipzig, Veb Georg Thieme, 1957. 201p. (In German)

8083
IMPROVED RADIATION INSTRUMENT FOR SIMPLIFIED DETERMINATIONS OF BLOOD VOLUME WITH ISOTOPES. Edmund A. Smolik, Wilfred Konneker, Francis P. Nash, and Raymond O. Muether (St. Louis Univ. School of Medicine, Mo., Neurosurgical Services of City, County, St. Louis, Mo., and DePaul Hospitals, St. Louis, Mo.). Am. J. Clin. Pathol. 26, 1133-6(1956) Oct.

ENHANCEMENT OF PROTECTIVE PROPERTIES OF ANTITETANUS SERUM AFTER ITS IRRADIATION WITH X-RAYS. R. V. Petrov. Bull. Exptl. Biol. Med. (U.S.S.R.) 41, 425-7(1956) May.

THERAPEUTIC USE OF ARTIFICIAL RADIOISOTOPES. Paul F. Hahn, ed. New York, John Wiley & Sons, Inc., 1956. 414p. London, Chapman & Hall, Ltd.
The therapeutic uses of artificial radioisotopes are reviewed. (C.H.)

10083 ORINS-12
Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.
RARE EARTHS IN BIOCHEMICAL AND MEDICAL RESEARCH: A CONFERENCE SPONSORED BY THE MEDICAL DIVISION, OAK RIDGE INSTITUTE OF NUCLEAR STUDIES, OCTOBER 1955. Granvil C. Kyker and Elizabeth B. Anderson, eds. 476p. Contract AT(40-1)-GEN-33. $2.20(OTS).
The chemistry of rare earth elements and compounds is reviewed. Procedures used in the production of rare earth radioisotopes are described. Data are presented on the tissue distribution of various rare-earth elements and compounds in laboratory and domestic animals. Pharmacological biochemical, and metabolic considerations for the internal administration of these elements are discussed. Possible diagnostic and therapeutic applications of rare earth radioisotopes and associated dosimetry problems are considered. (299 references.) (C.H.)

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