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A.E.C. RESEARCH AND DEVELOPMENT REPORT

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**ENGINEERING, QUARTERLY SUMMARY RESEARCH REPORT
JANUARY, FEBRUARY, AND MARCH, 1955**

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UNITED STATES ATOMIC ENERGY COMMISSION

QUARTERLY SUMMARY RESEARCH REPORT IN ENGINEERING

For January, February, March, 1955

by

Ames Laboratory Staff

June 25, 1955

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QUARTERLY SUMMARY RESEARCH REPORT IN ENGINEERING**For the period January, February, March, 1955**

This report is prepared from material
submitted by group leaders of
the Laboratory

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ENGINEERING

Under the direction of F. H. Spedding, G. H. Beyer,
G. L. Bridger, R. W. Fahien, R. W. Fisher, G. Murphy and
M. Smutz

Chemical Engineering

1. Separation of Individual Rare Earths by Solvent Extraction
(M. Smutz and F. H. Spedding)*

Equilibrium data have been determined for the rare earth nitrate-water-nitric acid-tributyl phosphate system. On the basis of this work, a nitric acid concentration of 5 normal in the aqueous phase has been selected for carrying out a continuous run. At this acidity, separation factors for the individual rare earths are about 1.5 between adjacent rare earths, low viscosities are encountered, solvent degradation is low and phases settle rapidly.

It has been found that a high purity lanthanum product, over 99% La_2O_3 , can be obtained from a cerium-lanthanum nitrate mixture by heating the solid nitrates at about 200°C in the presence of sodium or potassium nitrate. The cerium is decomposed to CeO_2 , permitting leaching away of the lanthanum nitrate. About 90% recovery of the lanthanum was obtained.

2. Zirconium Process Development (G. H. Beyer)

The production of massive zirconium metal by reducing zirconium tetrafluoride with magnesium is being studied. Pure anhydrous zirconium tetrafluoride is much easier to handle than the zirconium tetrachloride used commercially for making zirconium.

Anhydrous zirconium tetrafluoride will react with magnesium in a closed bomb, but chemical heat boosters such as zinc fluoride have been necessary to melt the zirconium and allow it to drain to the bottom of the bomb. Somewhat harder metal is produced using magnesium than using calcium as the reducing agent.

*Names indicate group leaders in charge of work.

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Engineering Development1. Slurry Program (G. Murphy)

A report (ISC-586) entitled "Ratio of Solid Velocity to Mixture Velocity in Slurry Flow" by Richard J. Burian will be distributed.

Abstract

Equations for the ratio of the velocity of the solid to the velocity of the mixture in the flow of a slurry were developed by both analytical and experimental means and the two equations compared. The empirical equation indicated that the velocity ratio is independent of concentration and the effect of temperature. Tests conducted to determine the distribution of the solid within the conduit verified the independence of the equation with concentration.

"Temperature Distribution in Bodies of Revolution that Contain a Heat Source" by Leslie Calhoun (ISC-587), was completed.

Abstract

The general partial differential equation for steady or unsteady state heat conduction in a body containing a heat source was first derived. This was accomplished by writing a heat balance on an element of the body. This equation was then transformed into a difference equation by means of the definition of a derivative. A new temperature scale was defined and the difference equation was rewritten in terms of the new temperature. A temperature variable was then defined in terms of the new temperature, the thermal conductivity, and the heat production.

Application of the difference equation expressed in terms of temperature variable to bodies of any shape and under various boundary conditions was discussed. This difference equation was then applied to hollow and solid right circular cylinders of various proportions. Temperature variable on the outer cylindrical surface was assumed to be at a uniform value of zero throughout. Values of temperature variable on the ends of the cylinder were assumed to vary linearly from zero at the outside to one hundred at the center. Temperature variable on the inside cylindrical surface of the hollow cylinders was assumed constant at a value of one hundred. For these temperature conditions, the results of a calculation for a cylinder of given proportions are compiled in a table expressing temperature as a function of position within the cylinder.

To utilize the results of the tables temperature variable must be reconverted to temperature. This conversion is then discussed. The accuracy of the solution and suggestions for future study are mentioned.

Ceramic Engineering

1. Metal-Ceramic Reactions (G. R. Pulliam, M. Smutz)

In this period the experimental work concerning the surface tension of cerium and lanthanum metals and their wetting of refractory oxides was nearly completed. The values of surface tension of cerium and lanthanum calculated thus far are: 710 dynes/cm for lanthanum, and 700 dynes/cm for cerium. Both measurements were taken at the melting point of the metals.

Cerium metal was found to attack alumina very rapidly, and the metal rapidly diffused into thoria. Both zirconia and beryllia were only slightly attacked, although the metal diffused into the zirconia plaques. Lanthanum attacked alumina quite readily. The metal wetted the thoria plaque, and diffused into the ceramic. Beryllia and zirconia were only slightly attacked by lanthanum at temperatures 300°C above the melting point of the metals.

Other Engineering Research

1. Circulation of Molten Metals (R. W. Fisher)

Final analytical results on the Th-Mg loop have been obtained and it was determined that no tantalum whatsoever was dissolved in the circulating alloy. Metallographic determinations have shown that the Th served as an oxygen getter and ThO₂ settled to the bottom of each of the pots and remained there up to a depth of approximately one-quarter inch, being mixed with the Th-Mg alloy. As a result of this very satisfactory experiment a second loop was constructed similar to the one described in ISC-614, except that the right-hand vertical container was omitted and the loop was filled with a Bi-U alloy of 5% U by weight. The system was evacuated, flushed with helium, and the run begun. With this system operating at approximately 950° at the high point, it was possible to obtain a Δt of slightly over 100°C.

This loop is constructed so that "thief" samples can be taken periodically to determine the composition of the alloy without shutting down the loop or destroying the evacuated system. In this way it will be possible to determine if the tantalum is going into the solution, indicating a corrosion or mass transfer effect. Several safety factors have been incorporated in this

loop so that a loss of pressure or a high build-up of pressure will shut down the experiment before the equipment is damaged. A new improved pump was installed in this system after first testing it in a single wall tube with pure Bi. As a result of the test it was determined that this particular pump had a pumping capacity of approximately 850 lbs. of Bi per minute at a head of one-half inch Bi. This is a considerably higher rate of flow than would be required in any fuel reprocessing system which might be used in connection with a reactor so it is not considered necessary to go to a higher capacity pump. The calculated pumping efficiency of this pump based on the Bi experiment, taking into consideration some necessary assumptions, was approximately 0.15%. This compares very favorably with literature reports on other electromagnetic pumps.

APPENDIX I: LIST OF REPORTS FROM THE AMES LABORATORY

1. Reports for Cooperating Laboratories

- ISC-506 Ames Laboratory Staff. Metallurgy. Quarterly Summary Research Report. April, May, June, 1954. SECRET.
- ISC-529 Ames Laboratory Staff. Engineering. Quarterly Summary Research Report. July, August, September, 1954. SECRET.
- ISC-530 Ames Laboratory Staff. Chemistry. Quarterly Summary Research Report. July, August, September, 1954. CONFIDENTIAL.
- ISC-532 Compiled by P. Chiotti and O. N. Carlson. Hanford Slug Program. Quarterly Summary Research Report. July, August, September, 1954. SECRET.
- ISC-533 Ames Laboratory Staff. Physics. Quarterly Summary Research Report. July, August, September, 1954. UNCLASSIFIED.
- ISC-535 R. D. Cooper and D. J. Zaffarano. Photodisintegration of Light in Nuclear Emulsions. UNCLASSIFIED.
- ISC-541 J. S. Wiley and M. Smutz. Separation of Thorium and Radium-228 by Solvent Extraction. SECRET.
- ISC-549 F. H. Spedding, J. E. Powell and D. M. Provow. Determination of the Equilibrium Constant for the Exchange of Nitrogen Isotopes between Ammonium Hydroxide Solution and Ammonium Ion Adsorbed on Dowex-50. SECRET.
- ISC-553 G. H. Beyer and R. B. Edwards. Flooding Characteristics of a Pulse Extraction Column. UNCLASSIFIED.
- ISC-558 C. L. Hammer and A. J. Bureau. A Method for the Prompt Destruction of the Electron Beam in a Conventional Synchrotron. UNCLASSIFIED.
- ISC-559 H. J. Hettel and V. A. Fassel. Determination of Fractional Part Per Million Amounts of Certain Rare Earths in Zirconium Metal. UNCLASSIFIED.
- ISC-561 C. L. Hammer and A. J. Bureau. A Method for the Prompt Destruction of the Electron Beam in a Conventional Synchrotron. II. UNCLASSIFIED.

- ISC-565 J. D. Corbett and S. vonWinbush. The Solubility of Some Metals in their Molten Halides. UNCLASSIFIED.
- ISC-566 J. A. Happe and D. S. Martin, Jr. Some Isotopic Exchange Reactions of Manganese. UNCLASSIFIED.
- ISC-567 R. F. Mitchell and D. S. Martin, Jr. High Specific Radioactivities of Osmium from Photonuclear Reactions. UNCLASSIFIED.
- ISC-568 D. E. Griffith and M. Smutz. Purification of Uranium by Solvent Extraction. SECRET.
- ISC-571 J. S. Fritz and M. Johnson. Volumetric Determination of Zirconium. UNCLASSIFIED.
- ISC-572 B. A. Rogers, L. Kied, Jr. and P. E. Palmer. The Rachinger Conversion Rule. UNCLASSIFIED.
- ISC-573 Ames Laboratory Staff. Engineering. Quarterly Summary Research Report. October, November, December, 1954. SECRET.
- ISC-578 W. A. Rhinehart, D. J. Zaffarano and R. C. Prior. An Accurate Digital Count-to-Analog Voltage Converter Employing a Reliable Decade Scaler. UNCLASSIFIED.
- ISC-581 J. D. Corbett and R. K. McMullan. The Lower Oxidation States of Gallium. I. The $\text{GaI}_3\text{-GaI}_2\text{-GaI}$ System. UNCLASSIFIED.
- ISC-583 L. S. Ring, Jr. The Photodeuteron/Photoproton Yield from Sulfur. UNCLASSIFIED.

2. Papers Published in Scientific Journals

- Goodman, L. and H. Shull
Molecular Calculations. III. A Modification of the Naive Semi-empirical MO Method. J. Chem. Phys. 23, 33-43, (January, 1955).
- Johansson, Sven A. E.
Experiments on the Direct Photonuclear Effect. J. Am. Chem. Soc. 77, 1393, (March, 1955).
- Johansson, Sven A. E.
Experiments on the Direct Photonuclear Effect. Phys. Rev. 97, 434-443, (January, 1955).

- Margoshes, M. and V. A. Fassel
The Infrared Spectra of Aromatic Compounds. I. The
Out-of-Plane C-H Bonding Vibrations in the Region
625-900 cm^{-1} . Spectrochim. Acta 7, 14-24 (1955).
- Margoshes, M. and V. A. Fassel
Infrared Functional Groups Analysis of Aryl Silanes.
Anal. Chem. 27, 351-355, (March, 1955).
- Morinaga, H.
Effects of Isotopic Skin and Selection Rules on Photo-
nuclear Yields. Phys. Rev. 97, 444-446, (January, 1955).
- Peterson, D. and R. Davis
Vapor Pressures and X-ray Diffraction Patterns of Some
Compounds in the Thorium Nitrate-water System. Phys.
Rev. 97, 434-443, (January, 1955).
- Pohm, A. V., R. C. Waddell, J. P. Powers and E. N. Jensen.
The Beta Spectrum of Cl^{40} . Phys. Rev. 97, 432-433,
(January, 1955).
- Vander Haar, R., G. V. Banks and R. Vander Wal
Magnetic Studies of Nickel(II) and Palladium(II)
Complexes with Some of Its Alloys. J. Am. Chem. Soc.
77, 324-325, (January, 1955).
- Wilder, D. R. and E. S. Fitzsimmons
Further Study of Sintering Phenomena. J. Am. Ceram.
Soc. 38, 66-71, (February, 1955).
- Williams, J. T.
The Vanadium-Zirconium Alloy System. J. of Metals. 7,
345-350, (February, 1955).

APPENDIX II: LIST OF SHIPMENTS

<u>Destination</u>	<u>Item</u>
Argonne National Laboratory Lemont, Illinois	50 lbs zirconium tetrafluoride
Army Medical Service Department of Biophysics Walter Reed Army Medical Center Graduate School Washington 12, D. C.	50 g yttrium oxide, 99% pure

<u>Destination</u>	<u>Item</u>
Astrophysical Lab, Vatican Observ. Attn: The Rev. Joseph Junkes S. J. Castel Gondolfo, Rome, Italy	2 g terbium oxide
Brookhaven National Laboratory Upton, Long Island, New York	20 g lutetium oxide
Brookhaven National Laboratory Upton, Long Island, New York	5 g neodymium metal
Brookhaven National Laboratory Upton, Long Island, New York	50 g cerium metal (high purity)
Carbide & Carbon Chemicals Company X-10 Plant P. O. Box P Oak Ridge, Tennessee	400 g yttrium oxide 400 g neodymium oxide
Dow Chemical Company Midland, Michigan	229 g uranium alloys
General Electric Company ANP Department Cincinnati, Ohio	50 lbs yttrium oxide (highest purity) 1 lb samarium metal (best grade available)
Dr. S. Jaffe Air Reduction Co., Inc. Research Laboratory Murray Hill, New Jersey	2 g thulium oxide (pure)
Knolls Atomic Power Laboratory Attn: W. L. Robb Schenectady, New York	40 g yttrium metal
Dr. Daniel Laszlo, Chief Division of Neoplastic Diseases Montefiore Hospital New York 67, New York	25 g yttrium oxide, 99.9%
Litton Industries Beverly Hills, California	3 thulium buttons
Los Alamos Scientific Laboratory University of California Los Alamos, New Mexico	100 g ytterbium oxide 100 g erbium oxide 100 g dysprosium oxide

<u>Destination</u>	<u>Item</u>
Mallinckrodt Chemical Works St. Louis, Missouri	200 lbs zirconium tetrafluoride
Dr. E. A. Martell Institute of Nuclear Studies University of Chicago Chicago, Illinois	100 g yttrium oxide (better than 90%)
Metals Research Laboratories Electro Metallurgical Company 4625 Royal Avenue Niagara Falls, New York	1 g lanthanum oxide 1 g cerium oxide 1 g praseodymium oxide 1 g neodymium oxide 1 g samarium oxide 1 g gadolinium oxide 1 g erbium oxide 1 g ytterbium oxide 1 g yttrium oxide 100 mg holmium oxide 100 mg dysprosium oxide 100 mg thulium oxide 100 mg lutetium oxide
University of Minnesota Room 126, Chemistry Minneapolis, Minnesota	1 g lanthanum oxide 1 g cerium oxide 1 g praseodymium oxide 1 g neodymium oxide 1 g samarium oxide 1 g gadolinium oxide 1 g yttrium oxide 1 g erbium oxide 1 g ytterbium oxide 100 mg holmium oxide 100 mg dysprosium oxide 100 mg thulium oxide 100 mg lutetium oxide
Monsanto Chemical Company Mound Laboratory Miamisburg, Ohio	1 g lanthanum oxide 1 g cerium oxide 1 g praseodymium oxide 1 g neodymium oxide 1 g samarium oxide 1 g gadolinium oxide 100 mg terbium oxide 100 mg ytterbium oxide 100 mg holmium oxide 100 mg erbium oxide 100 mg thulium oxide 100 mg lutetium oxide 500 mg dysprosium oxide

<u>Destination</u>	<u>Item</u>
National Lead Company of Ohio Fernald, Ohio	150 lbs zirconium tetrafluoride
Neval Research Laboratory Supply Officer Washington 25, D. C.	54 g lanthanum metal 51 g neodymium metal 52 g praseodymium metal 50 g gadolinium metal
Naval Research Laboratory Supply Officer Washington 25, D. C.	100 g thorium metal
Nuclear Metals, Incorporated 115 Massachusetts Avenue Cambridge 39, Massachusetts	10 g lanthanum oxide 10 g neodymium oxide 10 g gadolinium oxide 10 g erbium oxide
Oak Ridge Institute for Nuclear Studies, Inc. Oak Ridge, Tennessee	2 g lutetium oxide
Saturnium Corporation, Inc. California, Kentucky	1 g lanthanum oxide 1 g cerium oxide 1 g praseodymium oxide 1 g neodymium oxide 1 g samarium oxide 1 g ytterbium oxide 1 g gadolinium oxide 1 g erbium oxide 1 g yttrium oxide 100 mg holmium oxide 100 mg dysprosium oxide 100 mg thulium oxide 100 mg lutetium oxide
U. S. Bureau of Mines Raw and Precious Metals Experiment Station Reno, Nevada	1 g lanthanum oxide 1 g cerium oxide 1 g praseodymium oxide 1 g neodymium oxide 1 g samarium oxide 1 g gadolinium oxide 1 g yttrium oxide 1 g erbium oxide 1 g ytterbium oxide 100 mg holmium oxide 100 mg dysprosium oxide 100 mg thulium oxide 100 mg lutetium oxide 100 mg terbium oxide

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<u>Destination</u>	<u>Item</u>
Westinghouse Electric Corporation	19 g cerium metal
Research Laboratories	50 g gadolinium metal
East Pittsburgh, Pennsylvania	70 g neodymium metal
	50 g samarium metal
Dr. Geoffrey Wilkinson	10 g erbium oxide
Chemical Laboratories of Harvard	10 g dysprosium oxide
University	10 g ytterbium oxide
12 Oxford Street	
Cambridge 38, Massachusetts	

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