

NOVEMBER 1968



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Nitric Acid–Organic Mixtures Surveyed for Use in Separation by Anion Exchange Methods

Over 60 water-miscible organic solvents have been surveyed for use as components in mixed solvent–nitric acid elutriants for separation of the transplutonium elements by anion exchange. The survey entitled “Nitric Acid–Organic Solvent Mixtures for Separation of Plus-Three Actinides on Anion Resins,” was conducted by D. C. Stewart, C. A. A. Bloomquist, and J. P. Faris of the Chemistry Division of Argonne National Laboratory. Several solvents were found for accomplishing such separations, nine of which were found suitable for hot-cell use with high levels of radiation. Several solvent systems were found which gave excellent separation factors for americium–curium separations. Some solvent systems showed promise for the difficult separation of americium–promethium.

Use of mixed organic liquid–aqueous acid elutriants for anion resin column separation has recently received considerable attention. Nitric acid–methanol mixtures have been effective as elutriants in the separation of light rare-earth elements. Because of the similarity in chemical behavior between the plus-three transplutonium elements and the rare earths, it was expected that the same system could be used for certain actinide element separations.

Unlike most ion-exchange methods normally used to separate the rare-earth fission products from the transplutoniums and to separate the elements in each series, with the nitric acid–methanol mixture no corrosive or highly salted reagents are required, no precise control of pH is needed, the columns are operated at room temperature, the elutriant materials are inexpensive and available in high purity, and the products can be readily recovered from solution.

The methanol system, however, has drawbacks for operations with high levels of radioactivity, primarily because of the fire hazard that its use would involve. Thus a “shot-gun” survey was undertaken of as many solvents as possible having the required water miscibility to determine whether others could be found producing the same effects as methanol without the accompanying fire hazard. Other possible drawbacks of concern were deleterious effects on separations caused by radiation or prolonged contact with nitric acid, slowness in reaching equilibrium, change of K_D with macro loading of the columns, etc.

The survey described in this report was performed in three separate phases. In the first, a column elution–spectrographic analysis technique was used to compare certain solvents directly to the methanol system, using inert rare earths as stand-ins for the actinides. The second phase involved the batch determination of distribution ratios for americium between 90% solvent, 10% 5 M HNO_3 and Dowex 1 nitrate form resin for a large group of organics miscible in water. In the third phase, certain promising solvents found in the first two sets of experiments were used to determine batch distribution ratios for curium (to evaluate separation possibilities within the actinide group) and for promethium, terbium, and thulium (to determine the relative actinide–lanthanide positions and to evaluate possible separations within the heavy rare-earth group). Radioactive tracer techniques were used for all the batch experiments in the last two phases.

Notes:

1. Although transplutonium elements do not find industrial application, the techniques used in the survey could be of interest.

(continued overleaf)

2. In the study of the chemistry of the actinides and possibly the lanthanides, chemists may use some of the solvent systems to perform empirical laboratory investigations.
3. Reference: Details are contained in ANL-6999, "Nitric Acid–Organic Solvent Mixtures for Separation of Plus-Three Actinides of Anion Resins". The report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price \$3.00, (microfiche \$0.65).
4. Inquiries concerning this innovation may be directed to:

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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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