Support of Texas A&M for Development of Inorganic Ion Exchangers for Nuclear Waste Remediation

Oak Ridge National Laboratory
September 1997

Progress Report

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Research Objective

In this research program, Oak Ridge National Laboratory (ORNL) is collaborating with Texas A&M University in the development of highly selective inorganic ion exchangers for the removal of cesium and strontium from nuclear tank-waste and from groundwater. Inorganic ion exchangers are developed and characterized at Texas A&M University; ORNL is involved in preparing the powders in engineered forms and testing the performance of the sorbents in actual nuclear waste solutions.

Research Statement

The Texas A&M studies are divided into two main categories: (1) exchangers for tank wastes and (2) exchangers for groundwater remediation. These are subdivided into exchangers for use in acid and alkaline solutions for tank wastes and those that can be recycled for use in groundwater remediation. The exchangers will also be considered for in situ immobilization of radionuclides. The approach will involve a combination of exchanger synthesis, structural characterization, and ion exchange behavior.

ORNL has developed a technique for preparing inorganic ion exchangers in the form of spherules by a gel-sphere internal gelation process. This technology, which was developed and used for making nuclear fuels, has the potential of greatly enhancing the usability of many other special inorganic materials because of the improved flow dynamics of the spherules. Also, pure inorganic spherules can be made without the use of binders. ORNL also has access to actual nuclear waste in the form of waste tank supernatant solutions for testing the capabilities of the sorbents for removing the cesium and strontium radionuclides from actual waste solutions.

The ORNL collaboration will involve the preparation of the powdered ion exchangers, developed and synthesized at Texas A&M, in the form of spherules, and evaluating the performance of the exchangers in real nuclear waste solutions. Selected sorbents will be provided by Texas A&M for potential incorporation into microspheres, and the performance of the sorbents and microspheres will be examined using actual waste supernatant solutions. This collaborative program could potentially take an exchanger from concept, synthesis, structure determination, and elucidation of exchange mechanism, to engineered product and testing on real waste streams.

Research Progress

Funding for this activity became available in August of FY 1997. Several discussions have been held between ORNL and Texas A&M. A recipe for a simulant solution to be used as a surrogate for Melton Valley Storage Tank (MVST) supernatant was supplied to Texas A&M. The simulant solution will be used at Texas A&M to evaluate the prepared exchangers in batch tests, and selected exchangers will be sent to ORNL for incorporation into microspheres and testing on actual MVST supernatant for removing cesium and strontium.

A modified broth pot for making microspheres by the internal gelation process has been designed and is being fabricated. This broth pot is designed to prepare smaller batches of composite microspheres. Selected sorbent powders, prepared at Texas A&M, will be

incorporated into hydrous metal oxide microspheres to provide an engineered form. The composite microspheres will be evaluated for cesium and strontium removal from waste supernatant.

About 3 liters of MVST W-29 supernatant has been obtained for use in the batch tests of the cesium exchangers. Before use, the supernatant will be filtered in a hot cell using a 0.46-μm-pore- size filter to remove particulates. This supernatant has been characterized, and the concentrations of the sodium and potassium were determined to be 4.35 M and 0.44 M, respectively. The total cesium concentration is 1.2 mg/L, with about 11% ^{137}Cs. The strontium concentration is about 1.7 mg/L, mostly nonradioactive. The solution pH is 12.7. A hood in a radiological laboratory has been decontaminated and the necessary equipment assembled in preparation for the batch tests.

About 2 liters of filtered MVST W-29 supernatant, which was obtained as column effluent from previous hot cell tests, is being prepared for the batch tests with the strontium-selective sorbents. For easier handling and analysis, most of the cesium was removed by chromatography on IONSIV IE 911, a commercial engineered form of crystalline silicotitanate (CST). Strontium, traced with ^{85}Sr for better radiochemical analysis; will be added to the supernatant before the batch tests.