Development of Biodegradable Isosaccharinate-Containing Foams for Decontamination of Actinides: Thermodynamic and Kinetic Reactions between Isosaccharinate and Actinides on Metal and Concrete Surfaces

EMSP Project 82715

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RESEARCH OBJECTIVE

Actinide contamination of steel and concrete surfaces is a major problem within the DOE complex. Almost all current decontamination technologies rely on removal of the contaminated surface layer by mechanical means or by chemical methods using harsh chemicals. Some of the technologies are ineffective. Others are expensive, labor intensive, and hazardous to workers. Still others create secondary mixed wastes that are not environmentally acceptable. This project seeks fundamental information that will lead to the development of a new and more environmentally acceptable technology for decontamination of actinides, especially Pu, on steel and concrete surfaces. The key component of this technology is isosaccharinate (ISA), a degradation product of cellulose materials that is biodegradable. Isosaccharinate will be incorporated into foams/gels for safe and easy use in decontamination of actinides from steel, concrete, and other surfaces. Thermodynamic data are being developed on ISA species as a function of pH and on ISA interactions with actinides and competing metals [e.g., Fe(III) and Ca(II)] under a wide range of conditions relevant to decontamination of steel and concrete. The efficiency of the ISA containing foams/gels/solutions for decontamination is also being tested. This project builds on capabilities at three different national laboratories, and represents a joint effort between PNNL, LBNL, and SNL.

RESEARCH PROGRESS AND IMPLICATIONS

This is the final report for this project that was funded for three years (FY 2001-2004). The extensive data and results were presented in June 2004 report which summarized the results of nearly three years of research. The data from this project have been presented in several different open literature publications listed under information access. As a part of this project fundamental data on ISA reactions with Np(IV), U(VI), and Ca along with data on the ISA interactions with iron and proof of principle decontamination were obtained in order to assess the effectiveness of ISA as a decontaminating agent. These results collectively show that ISA holds great promise as a decontaminating agent but further research is needed to develop some of the

additional fundamental data and formulations for specific applications. The reader interested in this project should read the 2004 annual report along with the journal articles listed in the information access.

INFORMATION ACCESS

The research conducted under this project has resulted in the following technical communications.

Journal Articles

Rao, L., A. Yu. Garnov, Dhanpat Rai, Y. Xia, R. C. Moore. 2004. Protonation and Complexation of Isosaccharinic Acid With U(VI) and Fe(III) in Acidic Solution: Potentiometric and Calorimetric Studies. *Radiochimica Acta* 92: 575-581

Rai, Dhanpat, N. J. Hess, Y. Xia, L. Rao, H. M. Cho, R. C. Moore, Luc R. Van Loon 2003. Comprehensive Thermodynamic Model Applicable to Highly Acidic to Basic Conditions for Isosaccharinate Reactions with Ca(II) and Np(IV). *Journal of Solution Chemistry* 32: 665-689.

Cho, H. M., Dhanpat Rai, N. J. Hess, Y. Xia, and L. Rao. 2003. Acidity and Structure of Isosaccharinate in Aqueous Solution: A Nuclear Magnetic Resonance Study. *Journal of Solution Chemistry* 32: 691-702.

Bontchev, R. P. and R. C. Moore. 2004. Crystal Structure of Sodium Isosaccharate, $NaC_6H_{11}O_6H_2O$. Carbohydrate Research 339: 801-805.

Bontchev, R. P. and R. C. Moore. 2004. Crystal Structure of Ammonium Isosaccharate and Aqueous Solubility of Ammonium and Sodium Isosaccharinates. Carbohydrate Research 339: 2811-2816.

Technical Presentations

Rai, Dhanpat, L. Rao, R. C. Moore. "Development of Biodegradable Isosaccharinate-containing Foams for Decontamination of Actinides". 226th American Chemical Society national meeting, New York City, September 7-11, 2003,

Rao, L., A. Yu Garnov, Dhanpat Rai. 2003. Complexation of Uranium(VI) with Isosaccharinic Acid. Presentation at the 9th International Conference on Chemistry and Migration Behavior of Actinides and Fission Products in the Geosphere. Gyeongju, South Korea, September 21-26, 2003.

Rai, Dhanpat, R. C. Moore, M. D. Tucker, L. Rao. 2001. Development of Biodegradable Isosaccharinate-Containing Foams for Decontamination of Actinides: Thermodynamic and kinetic Reactions Between Isosaccharinate and Actinides on Metal and Concrete Surfaces.

Environmental Management Science Program, Deactivation & Decommissioning, Kickoff Workshop for 2001 Awards. Oak Ridge National Laboratory, November 27-28.

Rai, Dhanpat, R. C. Moore, M. D. Tucker, and L. Rao. 2002. Development of Biodegradable Isosaccharinate-Containing Foams for Decontamination of Actinides: Thermodynamic and kinetic Reactions Between Isosaccharinate and Actinides on Metal and Concrete Surfaces. In: Science to Support DOE Site Cleanup: The Pacific Nothwest National Laboratory Environmental Management Science Program Awards. PNNL-13928, Pacific Northwest National Laboratory, Richland, WA, PP. 2.21 – 2.23.

Holt, K., R. C. Moore, M. Tucker, F. Salas. 2002. Use of an Isosaccharinate Containing Gel for Decontamination of Actinide Contaminated Surfaces. Presented at the Meeting of the American Chemical Society, Albuquerque, NM. November, 2002.