Sustainable Nuclear Power Initiative

Pacific Northwest NATIONAL LABORATORY

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Transuranic Recycle Technology

Focus Area Fact Sheet

Focus Area Description

The Transuranic Recycle Technology (TRT) Focus Area, within the Sustainable Nuclear Power Initiative, conducts basic and applied research on novel concepts relevant to recycling irradiated nuclear fuel. This research is complementary to current R&D programs of the Department of Energy, as well as the commercial nuclear industry. Any decision to move from today's once-through use of nuclear fuel to a closed-fuel cycle will be highly complex with political, societal, economic and environmental factors to be considered. However, there is growing interest in this approach and corresponding increased R&D budgets for new nuclear technologies that will enable a critical 21st Century assessment of the pros and cons of a closed fuel cycle. This is coming at a time when the global nuclear community is making preparations to expand nuclear power generation. With a long lead time of 20 years or more to bring a fuel recycle facility online, R&D being conducted today is critical for a reasonable transition to recycling, should that decision be made, as well as continued U.S. engagement for worldwide nuclear policy and nonproliferation leadership as the world moves toward fuel recycling.

Science and Technology Capabilities

The Transuranic Recycle Technology Focus Area is organized around PNNL expertise in separations chemistry, a core capability needed for a U.S. recycling program. PNNL has historic roots in recycle technology, having led award winning R&D programs in separations processes, particularly actinide separations, during the Cold War and Department of Energy operations at the Hanford Site.

PNNL is developing a counter-current solvent extraction testing capability equipped with centrifugal contactors for radioactive application.

PNNL expertise in this area continues today and is complemented by the Laboratory's highly specialized nuclear facilities and laboratories. PNNL's Radiochemical Processing Laboratory is a Hazard Category 2 non-reactor nuclear facility, equipped for microgram-to-kilogram quantities of fissionable materials and megacurie activities of other radionuclides. Other features include two hot cell complexes for conducting work with highly radioactive materials, including irradiated fuel. These complexes provide unique capabilities for conducting bench-scale to pilot-scale work with a range of radioactive material. R&D performed in these cells also include waste characterization and processing verification, pretreatment, advanced analytics, isotope processing, advanced separations and reactor fuel handling. Work with classified material is conducted as well.

With a strong and targeted offering for recycle fuel technology research, the TRT Focus Area strategy is initially directed at developing small-scale R&D capabilities positioned to support broader national efforts in fuel recycle R&D.

Strategic scientific objectives of the TRT Focus Area include:

- Grow capabilities to support development of sustainable transuranic recycle technologies through lab-scale experimentation with actual radioactive feeds.
- Expand PNNL technical staff involvement in fuel cycle R&D

Transuranic Recycle Technology R&D

The TRT focus area features two novel FY08 LDRD projects:

- *Counter-Current Solvent Extraction Behavior of Neptunium* – This project will focus on design and assembly of a 2-cm centrifugal contactor test bed with on-line process monitoring/control and data collection, and will also be able to demonstrate safeguards technologies. The project will investigate Np chemistry under counter-current solvent extraction conditions, with an emphasis on co-extraction and recovery of Np with Pu and U. This research is essential for moving from the bench scale to larger systems by making the collection of chemistry data more affordable and timely. Additionally, the rapid assessment of effects and conditions will allow for exploration of different process approaches that may not otherwise be considered.

The Sustainable Nuclear Power Initiative Supports national priorities for:

- Energy Security
- Carbon Management
- Nonproliferation
- Sustainability

- *Dissolution of Actinides under Oxidizing Alkaline Conditions for Nuclear Energy Applications* – This project will focus on development of a more environmentally benign SNF dissolution process by 1) improving understanding of dissolution behavior of uranium and transuranium oxides under oxidizing alkaline conditions; 2) testing a "closed" digestion vessel to test gaseous by-product recycle in the alkaline dissolution process; 3) studying solution speciation and solid-state coordination of actinides in peroxide containing alkaline systems; and 4) demonstrating utility of the approach by alkaline dissolution of SNF at the bench scale. Data collected on SNF dissolution processes has the potential to form the basis of a more environmentally benign end-to-end reprocessing scheme for LWR fuel, and chemistry investigated could be applicable to the front end of the fuel cycle; i.e., uranium mining and recovery from ore.

PNNL nuclear research capabilities enable innovative, bench scale research that will help develop more environmentally friendly fuel cycle processes and which serve as a critical first step before larger-scale research can be performed.

- *Application of NF_3 to the Nuclear Fuel Cycle* – This project is developing the chemistry needed to demonstrate the application of nitrogen trifluoride to actinide fluoride volatility-based reprocessing and to conversion of reprocessing-recovered uranium to uranium hexafluoride for re-enrichment. This new actinide fluorinating agent is attractive because 1) it would provide a non-hazardous alternative to the highly toxic and reactive tandem fluorinating agents hydrogen fluoride and fluorine currently used for nuclear fuel cycle applications, and 2) it has been demonstrated in scouting thermoanalytical studies to effectively convert uranium metal, common oxides, and fluorides to the volatile uranium hexafluoride with different thermal selectivity. Successful demonstration of nitrogen trifluoride as a fluorinating agent for conversion of actinides could lead to viable fluoride volatility separations processes that could replace liquid-liquid extraction as the basis for nuclear fuel recycle, leading to a more economical process with less secondary waste.

TRT Investments

The investments made will result in the establishment of a counter-current solvent extraction testing capability equipped with up to sixteen 2-cm centrifugal contactors and on-line monitoring tools. Results from these projects will lead to publications in peer-reviewed journals and will be presented in technical forums.

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