National Spent Nuclear Fuel Program

Fuel Degradation and Release Rate Testing

Mission
Predict the probable degradation process and release rate of spent nuclear fuel in a repository environment

Benefits
- Create confidence in spent nuclear fuel models
- Provide vital data to prepare for the fuel degradation processes
- Ensure protection for the people and environment near the repository
- Provide data to predict potential changes in the stability of the spent nuclear fuel package

Current Issues
Acquiring the radioactive spent nuclear fuel test samples

Project Status
Experiments will continue until transportation of fuel to the repository begins

Purpose
In support of the repository license application process, the National Spent Nuclear Fuel Program is determining the expected release rate of radionuclides from spent nuclear fuel to predict the radiation dose rate at the repository boundary and assess the potential impact to criticality safety. The Code of Federal Regulations requires a technical basis for the degradation and release rate predictions for performance assessment of a repository system. Predictive models will provide the means to establish the technical basis.

Project Description
National Spent Nuclear Fuel Program researchers are performing a series of tests to simulate conditions in a repository and test a representative sample of the various spent nuclear fuel types managed by the U.S. Department of Energy (DOE). The researchers grouped the more than 250 DOE-owned spent nuclear fuel types and chose the four bounding fuel types for the tests. Varying the temperature, pH, oxygen content, and carbonate content provides information on the effects of individual parameters. Three primary tests support fuel degradation and release rate studies.

Unirradiated metallic uranium fuel corrosion: Test coupon completely corroded after 77 days in unsaturated test conditions at 90° C. Work performed at Argonne National Laboratory-East.

Drip testing is a long-term project that simulates actual repository system conditions. This test provides data about the mechanisms of degradation and characteristics of reaction products. Researchers are using the drip tests to measure radionuclide release in an unsaturated water environment.

Flow-through testing is a short-term project that provides a forward reaction rate (the dissolution rate that occurs without the interference of corrosion byproducts). Researchers quickly pass water over all surfaces of the fuel to achieve a continuous dissolution. This dissolution rate represents the expected worst-case dissolution rate and is needed as a parameter in performance assessment modeling.

Batch testing is a short-term project that measures compositional changes as water reacts with the spent nuclear fuel. Researchers introduce a thin layer of water, just enough to maintain a constant film, to the surface of a spent nuclear fuel sample. Then they closely monitor the changes in chemistry at the sample surface as the

water reacts with the sample to form reaction products, and then they examine the mechanisms of the reaction.

These tests are providing the means to obtain information about corrosion mechanisms, reaction products, and the retention and release of selected radionuclides. Researchers are performing additional analyses on samples from some of the tests to study the generation, characteristics, and stability of colloids.

Hot cells are used to manipulate radioactive samples. Hot cell shown is at Pacific Northwest National Laboratory.

Benefits

Researchers are gaining a better understanding of the degradation processes of uranium and other significant elements through these experiments. They are using these data to increase confidence (reduce uncertainty) in spent nuclear fuel performance assessment models.

Very little information is available on the studies of colloids in the area of nuclear research. Researchers are performing experiments on colloids to predict radionuclide release and transport properties to provide input to performance assessment models.

Unique Capabilities

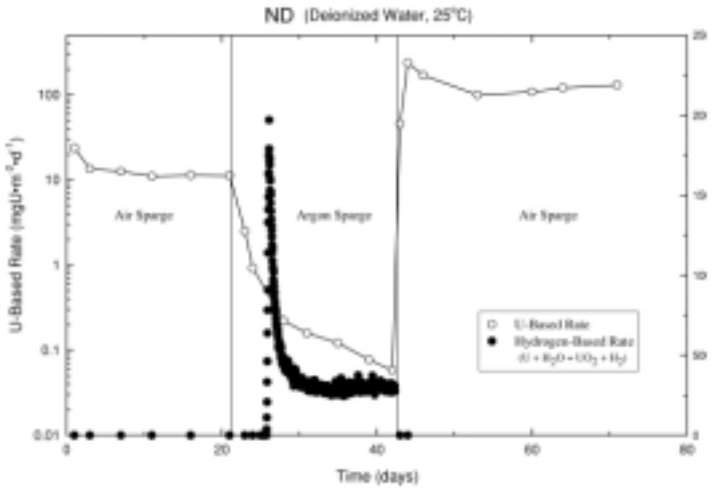
Researchers used actual DOE-owned spent nuclear fuel samples in these experiments. They are performing these experiments in hot cells and using special equipment that is also available for similar experiments. Strict quality assurance during all fuel samples testing ensures production of the highest data quality.

Current Issues

One major issue faced by researchers is the acquisition of spent nuclear fuel samples. The solution was to obtain samples during spent nuclear fuel repackaging processes and from various hot cell facilities where samples were available.

Project Status

Researchers will complete all experiments with mixed oxide fuel in Calendar Year 2001 except for the drip testing experiments. Drip testing will continue until fuel transport to the repository begins.



Unirradiated uranium metal corrosion rates in deionized water at 25°C.

May 1998
Flow-through testing on MOX fuel begins

July 1998
Drip testing on MOX fuel begins

October 1998
Batch testing on MOX fuel begins

February 1999
Drip testing on uranium metal fuel begins

1999
Flow-through testing on aluminum clad fuel finished

January 2000
Drip testing on aluminum clad fuel begins

August 2000
Batch testing on uranium metal fuel begins

2001
Experiments on mixed oxide fuel (except drip tests) completed

2002
Graphite/carbide fuel type testing (except drip tests) begins

Batch testing on aluminum clad fuel begins

Circa 2005
Testing on colloids finished

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