



Materials Aging

Mission

Extend the useful life of the standardized DOE spent nuclear fuel canister by minimizing its material degradation rate

Benefits

- Extend spent nuclear fuel canister lifespan
- Supports new long-lasting neutron absorber development
- Provides for spent fuel storage
- Contributes to more cost effective spent nuclear fuel storage processes

Current Issues

Timely development of 316L/gadolinium information

Project Status

- Developing optimized welding techniques for 316L stainless steel
- Study how weld heat input affects the thermal stability of 316L stainless steel
- Developing 316L/gadolinium neutron absorber
- Developing gadolinium oxide/Alloy 22 thermal spray coating

Purpose

Determine the degradation rate of the standardized U.S. Department of Energy (DOE) spent nuclear fuel canister and its neutron-absorbing material as they interact with the storage environment. Quantify the interim and long-term degradation effects for consideration in both the repository and canister design and safety analysis. Material corrosion and aging pose a significant problem to DOE with its need for long-term degradation-resistant storage systems for spent nuclear fuel.

Project Description

Research is being performed to determine the material degradation rates of the standardized DOE spent nuclear fuel canister and its neutron absorbing material as they interact with the interim storage and repository environment. The materials currently being evaluated are 316L stainless steel (the canister) and 316L alloyed with gadolinium and gadolinium oxide/Alloy 22 coating (anticipated neutron absorbing materials).

Environmental factors that can alter the canister materials are being identified. These factors include temperature, radiation, and internal and external canister chemistry. Once the known and predicted conditions are quantified, corrosion testing is performed.

The degradation rate must also be determined under interim storage conditions to

support the U.S. Nuclear Regulatory Commission transportation licensing process. An analytical model will be developed to predict the canister condition after interim storage and a corrosion monitoring/structural integrity program will be established for the interim storage facility. Finally, an analytical model is being developed to predict the release rate of the neutron-absorbing materials during interim and long-term storage.



Test cells are used to expose metal coupon to corrosive fluid, and measure the corrosion (degradation) rate. (microbiologically influenced corrosion)



These materials aging studies closely interface with the remote welding and nondestructive examination work being performed under the National Spent Nuclear Fuel Program. The information obtained from the degradation rate evaluations will be used to develop weld procedures that minimize or eliminate the possibility of intergranular attack and stress corrosion cracking; two damaging corrosion processes that diminish the life of the standardized DOE spent nuclear fuel canister. The welding technique must minimize heat input that could create sensitization (a thermally driven metallurgical reaction at or near the grain boundary) of the 316L stainless steel material. Material corrosion resistance and ductility could be lost through sensitization causing the useful canister life to diminish.



Removing 316L stainless steel coupons after heat sensitizing heat treatment.

Benefits

Materials aging (corrosion) testing data contributes to the increased life span designed into the standardized DOE spent nuclear fuel canister. It will quantify the performance of the canister and neutron absorbing materials under the expected storage conditions. Corrosion-resistant welding techniques will also be established based on these studies. The increased canister life span contributes to a more cost-effective spent nuclear fuel storage process.

Unique Capabilities

Through the National Spent Nuclear Fuel Program, highly experienced scientists and engineers are being brought together from the Idaho National Engineering and Environmental Laboratory, Sandia National Laboratories, and Lehigh University to perform the materials aging studies.

Current Issues

Little data exist about the 316L/gadolinium-alloy system. Its chemistry, melt practice, high temperature properties, and thermo-mechanical working practice (forging, rolling) must be determined to obtain useful materials aging data.

Project Status

Studies are currently being performed to develop an effective 316L stainless steel alloyed with gadolinium and the thermal spray coating of gadolinium containing Alloy 22 for neutron absorber material. The National Spent Nuclear Fuel Program has begun studies to determine the weld heat affects on the stability of stainless steel at the Bonneville County Technology Center in Idaho Falls, Idaho.

October 2000

Develop thermal techniques spray for applying gadolinium oxide (Gd_2O_3) measured mechanical properties

February 2001

Complete effect of welding on 316L performance

March 2001

Test subsurface coating

September 2001

Analyze results of testing and modify materials and procedures accordingly

October 2001

Develop stainless steel alloy 316L with gadolinium

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