Immobilizing Radioactive Waste

ADVANCED WASTE FORMS ARE MORE ROBUST

WHAT ARE ADVANCED WASTE FORMS?

Liquid waste from processing used nuclear fuel contains long-lived radioactive elements. To protect the environment and the public for millennia, this waste needs to be stabilized for eventual disposal by converting it to a solid form such as glass or glass-ceramic. Advanced waste forms such as ceramics containing crystal mineral may offer additional benefits, but have not yet been tested or demonstrated on a large scale.

WHY DOES IT MATTER?

The nation's arms race during the Cold War created millions of gallons of high-level radioactive liquid waste that is being immobilized for permanent geologic disposal. Nuclear energy doesn't currently create high-level liquid radioactive waste, but one day the U.S. may opt for a closed fuel cycle that recycles the fissionable materials remaining inside used nuclear fuel. This approach would generate liquid radioactive waste that would need to be cost-effectively stabilized into the most robust and concentrated form possible.

WHAT IS THE PROJECT?

Radioactive elements immobilized in glass are isolated from the environment. However, ceramic or hybrid glass-ceramic waste forms may resist damage more effectively while holding more radioactive elements — thereby creating a more durable and concentrated waste product that takes up less repository space. The Cold Crucible Induction Melter at Idaho National Laboratory is demonstrating production of such a waste form.

Molten material pours from INL's bottom-drained Cold Crucible Induction Melter during a demonstration to create an advanced glass-ceramic waste form.

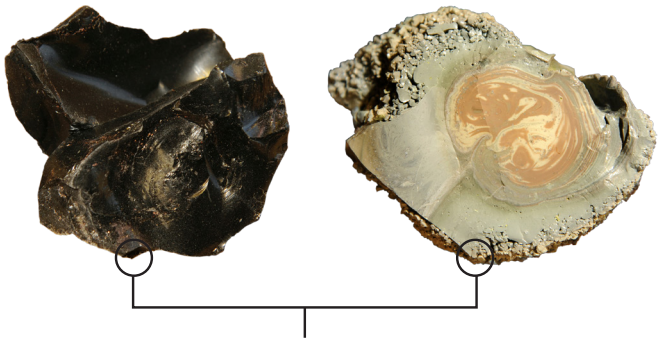
HOW IS IT GAME-CHANGING?

Cold crucible induction melting enables the effective processing of advanced waste forms with improved performance. This type of induction melter is less prone to equipment corrosion than other waste treatment methods. A unique heating method enables this melting technology to process radioactive wastes faster, more safely, and less expensively than other technologies. Its higher temperature capabilities can produce ceramic or glass-ceramic waste forms, which can concentrate more radioactive material, thus reducing demands on repository space.

WHAT'S NEW?

Cold crucible induction melting creates heat within a resistive substance simply by exposing it to a strong magnetic field while

For certain types of high-level liquid radioactive waste, glass waste forms (left) can hold no more than about 20 percent waste, while ceramic forms (right) can hold up to 45 percent with a greater long-term durability.



Ceramic waste forms (right) could hold two to three times as much radioactive waste as glass waste forms (left)

maintaining a thin skull of cooled glass between the melt and the crucible surface. The process is not new; however, the method recently was first demonstrated at a pilot scale to fabricate a hybrid glass-ceramic waste form at INL. Ongoing work is using radioactive surrogates to optimize the approach in an effort to create a fully ceramic waste form without any glass phases.

WHY DOE/INL?

The federal government is responsible for addressing the challenges associated with management of used nuclear fuel. The Department of Energy's Material Recovery and Waste Form Development Campaign is part of its Fuel Cycle Research and Development Program. The campaign is responsible for developing advanced technologies to support the various nuclear fuel cycle options defined in DOE's Nuclear Energy Research and Development Roadmap, Report to Congress, April 2010. INL has the only cold crucible induction melter prototype in North America residing within an integrated test bed that can measure the fate of waste feed components and demonstrate exhaust emissions control.

COLLABORATING LABS

IDAHO NATIONAL LABORATORY

PACIFIC NORTHWEST NATIONAL LABORATORY

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