Advanced nuclear fuel sets global performance record

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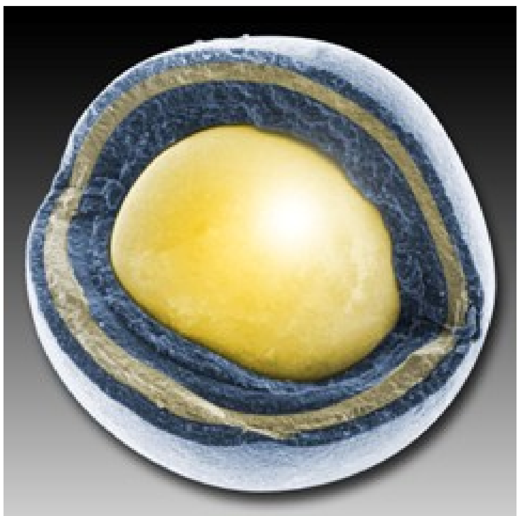

The fuel pellets contain a kernel of enriched uranium surrounded by carbon and carbide layers that act as a containment boundry for the radioactive material.

(PhysOrg.com) -- Idaho National Laboratory scientists have set a new world record with next-generation particle fuel for use in high temperature gas reactors (HTGRs).

The Advanced Gas Reactor (AGR) Fuel Program, initiated by the Department of Energy in 2002, used INL's unique Advanced Test Reactor (ATR) in a nearly three-year experiment to subject more than 300,000 nuclear fuel particles to an intense neutron field and temperatures around 1,250 degrees Celsius.

INL researchers say the fuel experiment set the record for particle fuel by consuming approximately 19 percent of its low-enriched uranium — more than double the previous record set by similar experiments run by German scientists in the 1980s and more than three times that achieved by current light water reactor (LWR) fuel. Additionally, none of the fuel particles experienced failure since entering the extreme neutron irradiation test environment of the ATR in December 2006.

"This level of performance is a major accomplishment," said Dr. David Petti, Director of the Very High Temperature Reactor Technology Development Office at the U.S. Department of Energy's INL. The purpose of the fuel program is to develop this particle fuel, produce experimental data that demonstrates to the Nuclear Regulatory Commission that the fuel is robust and safe, and re-establish a U.S. fuel manufacturing capability for high temperature gas reactors. INL has been working with Babcock and Wilcox Inc., General Atomics and Oak Ridge National Laboratory (ORNL) to establish standards and procedures for the manufacture of commercial-scale HTGR fuel. The overarching goal of the AGR Fuel Program is to qualify coated nuclear fuel particles for use in HTGRs such as the Next Generation Nuclear Plant (NGNP). Developing particle fuel capable of achieving very high burnup levels will also reduce the amount of used fuel that is generated by HTGRs.

"An important part of our mission is the development and exploration of advanced nuclear science and technology," said Dr. Warren F. "Pete" Miller, assistant secretary for Nuclear Energy. "This achievement is an important step as we work to enable the next generation of reactors, decrease fossil fuel use in industrial applications, make fuel cycles more sustainable, and reduce proliferation risks."

"AGR-1" is the first of eight similar experiments which aim to confirm designs and fabrication processes and performance characteristics for such fuel. Future AGR fuel tests will include particle fuel produced on a prototypic industrial scale to further prove the irradiation performance of the NGNP-specific fuel design. The 18-foot-long AGR-1 experiment was inserted in INL's ATR core and allowed for each of six capsules containing the particle fuel specimens to be monitored and controlled separately. Inside the ATR core, the fuel specimens were subjected to neutron irradiation many times higher than what they would experience inside an HTGR or a current light water reactor, allowing INL researchers to gain irradiation performance data for nuclear fuel and materials in a shorter time. The team is monitoring the AGR fuel for a number of factors including "burn-up," which is a measurement of the percent of uranium fuel that has undergone fission reactions.

Although the experiment has now left the ATR, researchers still have more work to do before the AGR-1 test campaign will be finished. Post irradiation examination (PIE) will begin at INL and ORNL facilities and allow scientists to examine the fuel up close so that the fuel and its layers of coatings can be evaluated for degradation patterns and other characteristics. In addition, controlled higher temperature testing in furnaces is planned to determine the safety performance of the fuel under postulated accident conditions. These activities will last another two years.

The Next Generation Nuclear Plant Program aims to use a high temperature gas reactor to produce high temperature process heat and hydrogen used by many industrial facilities in daily operations and to support the broader goal of developing the next generation of nuclear power systems that provide abundant carbon-free electricity on a 24/7 basis. Excellent fuel irradiation performance must be demonstrated before high temperature gas reactors can be licensed and co-located with these complementary industrial facilities. Reaching this world record peak burn-up of 19 percent without any particle failure demonstrates the robustness of this particle fuel design.

Source: Idaho National Laboratory