RECOVERY OF URANIUM-THORIUM FROM HTGR FUEL USING SALT-BASED GRAPHITE DIGESTION

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The Savannah River National Laboratory (SRNL) and Forschungszentrum Jülich GmbH are partnering in the development of a digestion technology for the processing of graphite-based high temperature gas reactor (HTGR) nuclear fuels. SRNL has proposed a salt-based process for digesting the graphite and SiC and isolating the nuclear fuel.

SRNL has successfully demonstrated the conversion of the graphite in HTGR fuel to digestion byproducts salt using a mixture of molten salts. The same chemical system also reacts with the silicon carbide in TRISO fuels. The system can be configured to react with graphite and not silicon carbide, which would be appropriate for BISO fuels. The reactions with graphite occur effectively between 500 and 800 °C with the graphite reaction rate increasing linearly as a function of temperature.

Four process demonstrations were completed with a system for graphite-only digestion. Two of the tests involved incremental addition of graphite with rapid digestion. The other two tests charged a single large sample that was digested in a controlled manner. The process chemistry was successfully extended to the processing of full HTGR BISO pebbles containing unirradiated U/Th oxide fuel kernels. Complete digestion has been demonstrated for 200-g A3 graphite pebbles and unirradiated BISO fuel pebbles. Testing proved that the reaction temperature can be regulated and that proposed mechanisms for discontinuing the reaction are effective. Small-scale experiments have investigated the behavior of fission products using both irradiated fuel kernel and non-radioactive simulant studies.

Incremental addition of graphite yielded the use of 10.2 g of salt per gram of graphite digested. Two tests with individual large samples used 11.2 g of salt per gram of graphite digested. Recent developments have identified salt regeneration methods which have the potential to greatly reduce waste volumes, material handling issues, and process complexity.