Elysium Industries
partnered with
Idaho National Laboratory and Argonne National Laboratory

RFA-17-14592, Synthesis of Molten Chloride Salt Fast Reactor Fuel Salt from Spent Nuclear Fuel

YEAR AWARDED: 2017

TOTAL PROJECT VALUE: $288K (DOE funding, $230K; awardee cost share, $58K)

STATUS: Completed

PRINCIPAL LAB INVESTIGATORS: Florent Heidet (fheidet@anl.gov)

DESCRIPTION: In June 2017, Elysium was awarded a Department of Energy (DOE) Gateway for Accelerated Innovation in Nuclear voucher to convert spent nuclear fuel into molten-chloride-salt fuel. The work was done at Idaho National Laboratory (INL) with support from Argonne National Laboratory (ANL) and was intended to demonstrate the streamlined development of fuel salt manufacturing from spent nuclear fuel. Elysium is developing a concept for a molten-chloride-salt fast reactor for the purpose of utility-scale electrical power generation. In this reactor concept, the molten chloride salt is both the fuel source and coolant for the reactor. The actinides used to manufacture the molten salt are chemically recovered from used nuclear fuel, dispositioned weapons-grade and reactor-grade plutonium stock, and highly enriched uranium and natural uranium stock.

BENEFIT: Developing a technology for developing fuel salt from spent nuclear fuel is critical to solving the most important and costly existing commercial nuclear waste issues. Utilities could eventually generate carbon-free energy (electricity, process heat, etc.) while using their spent nuclear fuel. This would considerably reduce fuel costs as well as those related to security and safety in the commercial nuclear sector.

IMPACT: Elysium asked its DOE partners to study the exchange chemistry between irradiated mixed-oxide (MOX) fuel and a ternary molten salt (e.g., NaCl-KCl-ZrCl4). The MOX fuel was taken from an inventory of the Fast Flux Test Facility reactor fuel present in the Hot Fuel Examination Facility argon-atmosphere hot cell located at the INL Materials & Fuels Complex. Throughout the study, the salt was maintained at approximately 700°C. All indications are that the chlorination strategy was successfully demonstrated.

NEXT STEPS: In 2018, DOE awarded Elysium $3.2 million for an Advanced Reactor Development Project, “Modeling and Optimization of Flow and Heat Transfer in Reactor Components for Molten Chloride Salt Fast Reactor Application.” This project will develop the computational fluid dynamics models needed to simulate and optimize the flows of molten-chloride-salt fuel in a reactor vessel and heat exchangers for their molten-chloride-salt fast reactor design.