Flibe Molten Salt Processing

Flibe Energy, Inc., Huntsville, Alabama
Randall Scheele, principal investigator
Andrew Casella, co-principal investigator

Nuclear reactors that use molten salts as a fuel medium, particularly liquid-fluoride fuel salts, can operate without concern about radiation damage to their fuel form. They can also refuel while operating. Only the buildup of fission products limits their operational lifetime, and techniques have been proposed that can address this constraint as well. The most attractive technique for the removal of fission products is called reductive extraction and tends to remove the uranium fuel before the fission products. Therefore it is very desirable to chemically remove uranium from the fuel salt prior to the removal of fission products. Fluorination of soluble uranium tetrafluoride to gaseous uranium hexafluoride has been proposed and demonstrated in the Molten-Salt Reactor Experiment.

The fluorine gas that was used for fluorination of fluoride salt in the past is very reactive and exceptionally corrosive. We propose using nitrogen trifluoride as a safer, less aggressive, and more tunable fluorination agent to accomplish the same goal. In our proposed work, we would utilize a laboratory at PNNL's Radiochemical Processing Laboratory to conduct development work on NF3 fluorination of a lithium fluoride, beryllium fluoride (LiF-BeF2) salt mixture that also contains small amounts of UF4. Various experimental stations would be set up and the materials would be procured to undertake this experiment. Advanced sensors and instrumentation that have been developed at PNNL would also be employed for exceptional experimental precision. The project would take two years and would demonstrate NF3 fluorination under a variety of uranium concentrations and salt conditions. Molybdenum would also be fluorinated as a simulant for the noble metal class of fission products.

Successful demonstration of NF3 fluorination would resolve one of the major challenges to chemical processing faced by a whole class of liquid-fluoride nuclear reactors. This project would be followed by other efforts to demonstrate reductive extraction of fission products and the reconstitution of fuel salt from gaseous UF6. Other applications for the technology include the potential treatment of waste streams from other molten-salt reactor experiments, and uranium recovery from a variety of other waste forms.

The deliverables from the project would be reports and journal articles that would be disseminated to the public.