NUCLEAR ENERGY RESEARCH INITIATIVE

Liquid Salts as Media for Process Heat Transfer from VHTRs: Forced Convective Channel Flow Thermal Hydraulics, Materials, and Coatings

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Collaborators: None

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Project Description

This project investigates using liquid salts as heat transfer fluids to utilize process heat from very high temperature reactor (VHTR) and other Generation IV reactors for hydrogen production. Favorable thermal properties (e.g., lower melting point, high boiling point, high heat capacity, chemical stability, and low pumping power requirements) allow for efficient transport of high-temperature thermal energy. Successful implementation of the liquid salt reactor/hydrogen production process interface will require an accurate assessment of the thermal hydraulics in small diameter channel, high-efficiency compact heat exchangers. In these small channels, under high flow velocity and high temperature conditions, both thermal hydraulics and materials will be key operational issues. In particular, information on corrosion/erosion resistance of materials and coatings for the construction of intermediate heat exchanger systems will be needed along with operational experience to determine the minimum channel sizes to avoid clogging and to optimize heat transfer.

Workscope

1) Investigate materials and coatings corrosion performance in liquid salts by performing static corrosion tests of Alloy 800H, carbon-carbon composite, and Inconel 600 in liquid FLiNaK and liquid $MgCl_2$-KCl salts at 850ºC for 500 hours

2) Fabricate a forced convection loop paired with a commercial liquid salt pumping system to achieve high velocity flows to study:
   - Thermal hydraulics in small channels to determine optimum heat transfer configuration while avoiding clogging due to corrosion products
   - Particle transport and deposition in liquid FLiNaK salt at 850ºC for 1,000 hours

3) Evaluate materials and coating technologies for corrosion, erosion, and small channel clogging under prototypic velocity liquid salt flow conditions:
   - Optimized Ni electroplating and hard carbon coating/carbon-carbon composite
   - Electroplated Ni and hard carbon coating