NEUP Nuclear Energy University Program
U.S. Department of Energy

Hi-fidelity characterization of molten salt – graphite pore interactions through experiments and embedded modeling

PI: Jacob Eapen
NC State University.

Program: Topic 11
Advanced Nuclear Materials

Collaborators: Stephen Raiman,
University of Michigan, Ann Arbor.
Anne A. Campbell, Oak Ridge National Laboratory.
David Hill, Terrestrial Energy USA.
Abbie N. Jones, University of Manchester.
Arash Rabbani, University of Leeds.

ABSTRACT:

Graphitic components are subjected to fast neutron flux in a molten salt reactor (MSR) for several years and there is a potential for salt or fuel salt infiltration into the bulk graphitic regions. Salt infiltration is generally considered to be unfavorable or harmful to the operation of an MSR due to the potential for graphite degradation, transport of fission products such as ^{135}Xe that can decrease moderation, generation of hotspots, and fuel inventory change. In general, salt permeation and transport, which are dependent on the salt thermodynamics and kinetics, depend critically on the pore/crack shape, morphology and interconnectivity that are not yet well-elucidated.

We propose a suite of fuel salt (FLiBe with U) infiltration experiments followed by X-ray computed tomography, mechanical property evaluation, and high-fidelity data analytics and modeling along with complimentary porosimetry measurements and XPS analysis. Three graphite grades are selected in this project: NBG-18, IG-110 and POCO: ZXF-5Q; the selected grades will cover the typical porosities observed in nuclear graphite. The main objective of our investigation is to draw out the differences in fuel salt infiltration behavior in the selected graphite grades and assess the change in mechanical properties. We anticipate that our work will assist in selecting nuclear graphite grades optimized for the current and advanced MSRs.