Experimental Determination of Helium/Air Mixing in Helium Cooled Reactor

PI: Victor Petrov
(University of Michigan)

Program: High Temperature Gas Reactor (HTGR) Scope RC-4.2

Collaborators:
Xiaodong Sun – University of Michigan
Richard Christensen – University of Idaho
Piyush Sabharwall – Idaho National Laboratory

ABSTRACT:

The High Temperature Gas Reactor (HTGR) faces unique challenges in terms of coolant escape and air ingress after vessel depressurization in the event of primary piping boundary failure. One of the most serious potential accidents in the Generation IV HTGR is leakage of primary coolant (Helium) through a catastrophic break, which becomes a very serious event in terms of loss of cooling, oxidation of fuel elements, and potential for release of radioactive material to the environment.

This project proposes to examine the mixing and venting of helium and reactor cavity air after a loss-of-forced-cooling due to a break in the primary coolant boundary using the following three investigations:

1. Near field experimental examination of He/Air mixing behavior and air ingress in the event of reactor breaks.
2. Far field experimental examination of He/Air mixing behavior within the cavity between the reactor vessel and the power conversion vessel and the containment in the event of breaks associated with the cross vessel.
3. Computational Fluid Dynamic modeling of He/Air mixing behavior to inform or identify placement of instrumentation for experimental work. Subsequent models shall be developed from the experimental data generated by both UM and UI teams.

Understanding the dynamic behavior of He/Air mixing in the context of the containment geometry is essential to develop systems and scenarios to mitigate damages in such an event. To address gaps in experimental work and models:

- experimental scaled reactor system mockups will be built and installed at UM and UI laboratories
- Mixing and venting of helium and reactor cavity air in the Reactor Pressure Vessel volume and the corresponding cavity will be modeled.