NUCLEAR ENERGY UNIVERSITY PROGRAMS

Investigation of Countercurrent Helium–Air Flows in Air-ingress Accidents for VHTRs

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Abstract

The primary objective of this research is to develop an extensive experimental database for the air-ingress phenomenon for the validation of computational fluid dynamics (CFD) analyses. This research is intended to be a separate-effects experimental study. However, the project team will perform a careful scaling analysis prior to designing a scaled-down test facility in order to closely tie this research with the real application. As a reference design in this study, the team will use the 600 MWth gas turbine modular helium reactor (GT-MHR) developed by General Atomic. In the test matrix of the experiments, researchers will vary the temperature and pressure of the helium—along with break size, location, shape, and orientation—to simulate deferent scenarios and to identify potential mitigation strategies.

Under support of the Department of Energy, a high-temperature helium test facility has been designed and is currently being constructed at Ohio State University, primarily for high-temperature compact heat exchanger testing for the VHTR program. Once the facility is in operation (expected April 2009), this study will utilize high-temperature helium up to 900°C and 3 MPa for loss-of-coolant accident (LOCA) depressurization and air-ingress experiments. The project team will first conduct a scaling study and then design an air-ingress test facility. The major parameter to be measured in the experiments is oxygen (or nitrogen) concentration history at various locations following a LOCA scenario. The team will use two measurement techniques: 1) oxygen (or similar type) sensors employed in the flow field, which will introduce some undesirable intrusiveness, disturbing the flow, and 2) a planar laser-induced fluorescence (PLIF) imaging technique, which has no physical intrusiveness to the flow but requires a transparent window or test section that the laser beam can penetrate. The team will construct two test facilities, one for high-temperature helium tests with local sensors and the other for low-temperature helium tests with the PLIF technique. The results from the two instruments will provide a means to cross-calibrate the measurement techniques.