Validation data for Depressurized and Pressurized Conduction Cooldown

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ABSTRACT

Very high-temperature gas cooled reactors have low power density, high operating temperatures, and passive safety systems. They have the potential to produce safe and reliable baseload electrical power coupled with CO_2-free high-quality process heat for industrial applications. The next generation nuclear power plant is a planned prototype to demonstrate this technology. As part of this effort an integral effect test loop facility is being built at Oregon State University, the High-Temperature Test Facility (HTTF). It has been designed to model the behavior of interest for a Very High Temperature Gas Reactor (VHTR) during the Depressurized Conduction Cooldown event. It also has the ability to conduct limited explorations into the progression of the Pressurized Conduction Cooldown event and phenomena during normal operations. *Both events will be studied by a combination of in-situ velocity field, pressure, and temperature measurements, coupled with computational fluid dynamic (CFD) simulation. Experimental measurement of velocity is critical to provide proper boundary conditions to validate CFD codes as well as developing correlations for system level codes, such as RELAP5. Such data will be the first acquired in the HTTF and will also introduce a diagnostic with numerous other applications to the field of nuclear thermal hydraulics.*

To achieve this objective, researchers at the George Washington University and Oregon State University will collaborate with a NASA Langley Research Center scientist who is an expert in laser spectroscopic techniques for gas flows measurements, particularly, molecular tagging velocimetry (MTV). MTV will be adapted to high-pressure and temperature conditions and deployed in the HTTF to measure flow velocity in the facility inlet plenum.

Successful completion of the project will greatly benefit the nuclear engineering field and future reactors development. The acquired high-spatio-temporal resolution velocity data coupled with CFD will enable the PIs to *1) support code validation efforts of DCC; 2) refine phenomenological analysis of air ingress and natural convection during DCC events; 3) elucidate the strength of the buoyant plumes during PCC, 4) assess scaling parameters for PCC in the HTTF.*

Furthermore, this project will generate high-resolution databases that are needed for future safety code development (such as RELAP 7). In addition, a new state-of-the-art non-intrusive and non-perturbative diagnostics will be introduced to the thermal hydraulics filed. This tool allows measuring velocity, temperature, and pressure in gases and has been developed in aerospace fields. Once adapted to conditions encountered in nuclear reactors, the obtained data will be transformative to many aspects of DOE core mission. They will enable to validate multiphase numerical models, investigate containment building and RCCS response under accident conditions, etc. Such results will be invaluable to gain new physical insights into complex phenomena and to refine operating safety margins. Finally, gas cooled reactors under development, such as General Atomics EM^2, will also benefit from this effort.