PURDUE UNIVERSITY | School of Nuclear Engineering

Nuclear Engineering Seminar

Dr. Hitesh Bindra

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3:30pm | PHYS 112

Experimental study on the stratification and mixing in liquid metal-cooled reactors

Abstract

Stratification and mixing in large enclosures such as plena can significantly impact the safety of liquid metal-cooled reactors (LMRs). Particularly, thermal stratification in the hot plena of LMRs under off-normal transients is one of the least understood problems that have Multiphysics effects on thermo-mechanics and neutronics. This is primarily due to the lack of highfidelity experimental data for validating Computational Fluid Dynamics (CFD) or system scale models, which are essential for improved understanding. A scaled liquid metal (Gallium) thermalfluidic setup with a scaled hot plenum has been developed at Kansas State University to study different transients. Experimental results of cold-shock transients were obtained from Optical Frequency Domain Reflectometry and Acoustic Backscattering instrumentation deployed in the liquid metal loop. Time-dependent velocity and temperature field data in the scaled plenum are obtained using these sensors. Critical parametric estimates such as critical Richardson number and turbulent Prandtl number are identified from the experimental studies to classify the molecular, transitional, and energetic regimes of mixing extent. The sustained thermal fluctuations in the plenum were observed when flux Richardson number is less than or equal to the critical value. CFD codes with large eddy simulations (LES) were used to simulate the cold-shock transients and were validated against the experimental data.

This talk will further present the broader research focus and educational vision of Dr. Bindra on nuclear engineering and nuclear energy systems.

Dr. Hitesh Bindra is the Steve Hsu Keystone Faculty Research Scholar and Associate Professor at Kansas State University. He is the director of the Nuclear Energy Systems Transport (NuEST) laboratory. He has several years of industrial experience as a nuclear power plant engineer and thermal analysis engineer. He has led projects involving fluid mechanics and thermal transport problems related to water-cooled or advanced nuclear reactors. Dr. Bindra's group has developed a unique Gallium Thermo-fluidic Experiment facility to understand safety-related thermal transients in liquid metal cooled reactors. This laboratory also has multiple helium-cooled loops to study pressurized conduction cooldown and depressurized loss of forced convection in High Temperature Gas-cooled reactors. Most of the experimental facilities in the NuEST laboratory are equipped with state-of-the-art instrumentation to generate benchmark or validation grade data for safety analysis or CFD codes. His group develops data-driven closure relations and surrogate models from experiments, field data or validated high fidelity codes to improve safety or technoeconomic analysis of nuclear energy systems. Dr. Bindra has also invented and developed thermal stratification based heat storage technology ideal for integration with nuclear hybrid energy systems.