PURDUE UNIVERSITY | School of Nuclear Engineering

Nuclear Engineering Seminar

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Hitesh Bindra is an Associate Professor of Nuclear Engineering at Purdue University. He is the director of the Nuclear Energy Systems Transport (NuEST) laboratory where his research group focuses on thermal-fluid sciences with applications in advanced nuclear reactors and heat storage systems. His group members have developed multiple scaled experimental facilities to investigate safety and design issues in Gen 4 small-modular reactors. He has several years of industrial experience as a nuclear power plant engineer and thermal systems engineer.

Wednesday, February 26, 2025

3:30 pm | FRNY G140

Passive safety and loss of forced circulation in High Temperature Gas-Cooled Reactors

Abstract

High Temperature Gas-Cooled Reactors (HTGRs) are at the forefront of next-generation nuclear technology, offering high thermal efficiencies and a suite of inherent safety features. This seminar will first showcase the passive safety mechanisms in HTGRs—in maintaining reactor integrity during abnormal conditions. The focus will be on the challenges and implications of a loss of forced circulation in different HTGR designs. The presentation will provide an overview of HTGR design principles and the inherent safety advantages provided by high thermal inertia and robust core materials. We will then delve into the thermal-hydraulic phenomena associated with loss of forced circulation, emphasizing the transition to natural convection and its impact on heat removal processes. Through analysis of recent experimental studies and simulation results, the seminar will address key questions about the reliability of passive safety systems and strategies to optimize reactor response under off-normal conditions. The Transformational Challenge Reactor (TCR) draws inspiration from High-Temperature Gas-Cooled Reactors (HTGRs) and leverages the advantages of additive manufacturing technology, particularly by incorporating additively manufactured fuel elements. Similar to HTGRs, the TCR incorporates engineered passive safety features designed to effectively remove heat during a Loss of Forced Cooling (LOFC) event. The more compact, additively manufactured, ceramic fuel elements can be conveniently produced with optimally configured channels that suppress the air ingress progress and improve thermofluidic performance. DLOFC and air ingress are experimentally studied in a scaled high temperature helium test setup. The experimental studies were conducted using an AM test element embedded with a distributed temperature sensor as well as a test geometry comprised of spherical pebble bed elements. The results show that the AM part delayed ONC as compared to the more conventional HTGR designs and can be used to design advanced core and fuel for future HTGRs.