NUCLEAR ENERGY UNIVERSITY PROGRAMS

An Innovative and Advanced Coupled Neutron Transport and Thermal Hydraulic Method (Tool) for the Design, Analysis and Optimization of VHTR/NGNP Prismatic Reactors

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Abstract

This project will develop a 3D, advanced coarse mesh transport method (COMET-Hex) for steady-state and transient analyses in advanced very high-temperature reactors (VHTRs). The project will lead to a coupled neutronics and thermal hydraulic (T/H) core simulation tool with fuel depletion capability.

The computational tool will be developed in hexagonal geometry, based solely on transport theory without (spatial) homogenization in complicated 3D geometries. In addition to the hexagonal geometry extension, collaborators will concurrently develop three additional capabilities to increase the code's versatility as an advanced and robust core simulator for VHTRs. First, the project team will develop and implement a depletion method within the core simulator. Second, the team will develop an elementary (proof-of-concept) 1D time-dependent transport method for efficient transient analyses. The third capability will be a thermal hydraulic method coupled to the neutronics transport module for VHTRs.

Current advancements in reactor core design are pushing VHTRs toward greater core and fuel heterogeneity to pursue higher burn-ups, efficiently transmute used fuel, maximize energy production, and improve plant economics and safety. As a result, an accurate and efficient neutron transport, with capabilities to treat heterogeneous burnable poison effects, is highly desirable for predicting VHTR neutronics performance. This research project's primary objective is to advance the state of the art for reactor analysis.