NUCLEAR ENERGY UNIVERSITY PROGRAMS

Creation of a Full-Core HTR Benchmark with the Fort St. Vrain Initial Core and Validation of the DHF Method with Helios for NGNP Configurations

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Abstract

This project will develop benchmark cases from initial cores of the Fort Saint Vrain (FSV) gas-cooled high-temperature reactor (HTR). The project team will identify suitable benchmark configurations with known geometry and composition data that have associated experimental data to compare with predicted results. The team will analyze these benchmark configurations by high-resolution Monte Carlo simulations, and compare results with the experimental data and other available predicted results.

Researchers will use these benchmark cases to validate the "double heterogeneity factor" (DHF) method developed at the University of Michigan that allows analysis of arbitrary TRISO fuel configurations (ranging from a microsphere cell to full-core) with a conventional lattice physics code such as Helios that is used for light water reactors (LWRs). The DHF method relies on two full-core Monte Carlo calculations to compute the double heterogeneity, which are then used in Helios to analyze HTR configurations. The advantage of this approach is that all neutronic effects due to local or global interactions, including depletion, are captured, assuming that the full-core Monte Carlo analysis with explicit TRISO fuel yields an accurate result. The team will also explore the adequacy of a simplified DHF methodology that relaxes the need to perform full-core Monte Carlo calculations. Researchers will validate both the full and simplified DHF approaches against the FSV benchmark cases. This project has three primary objectives:

- Develop and perform MCNP5 simulation of full-core HTR benchmark cases using data and information from the startup and operation of the FSV HTR in 1976-83.
- Validate Helios and the project DHF method for benchmark FSV configurations with TRISO fuel.
- Validate the simplified DHF methodology that eliminates the need for the full-core Monte Carlo simulations.