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Neutronic Analysis of the SMART Core

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This work presents a preliminary neutronic analysis of the SMART (System-integrated Modular Advanced Reactor), a small modular integral PWR developed by KAERI. The study, conducted at the Nuclear Engineering Department of the Federal University of Minas Gerais (DEN-UFMG), aims to support the future integration of thermal-hydraulic and neutronic simulations for accident-tolerant fuel (ATF) analysis in SMRs. In this initial phase, the macroscopic cross sections of the SMART reactor core were generated using the deterministic lattice code WIMSD-5B and then provided as input to the PARCS core simulator to evaluate reactor behavior under steady-state conditions.

The SMART reactor design includes 57 fuel assemblies, divided into four fuel types (A, B, C, D), each modeled as a homogenized unit cell composed of concentric annular regions. Fuel rods consist of UO_2 enriched to 4.95 w/o of U-235, gadolinia-bearing rods (Gd_2O_3–UO_2), and Al_2O_3–B_4C control rods with B-10 enriched to 30 w/o. Based on KAERI reference documents, reactor geometry and material composition were processed for two-group cross section generation. These were used to feed the PARCS code, along with kinetic parameters, to simulate the reactor core.

The results yielded consistent macroscopic cross section data and an effective multiplication factor of keff = 1.158462, indicating supercriticality and homogeneous power distribution, in line with SMART design references. Although preliminary, these results validate the modeling approach and support future coupling with RELAP5 for transient safety analysis and ATF performance assessment.

Technical Track

Reactor Physics

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