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Loss of Flow Transient Analysis of a Small Modular Reactor during Normal Operation

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In light of the escalating climate crisis, the global dependence on fossil, non-renewable, and polluting energy sources presents a significant challenge to mitigating the adverse environmental and climatic effects resulting from the unchecked use of such sources. In this context, nuclear energy emerges as a clean and environmentally friendly alternative, with the potential to meet the growing energy demand efficiently, on par with more conventional energy sources. Small Modular Reactors (SMRs) stand out as promising contenders in the global nuclear sector, offering advantages such as operational flexibility, robust safety measures, and the ability to meet local energy demands. These reactors hold substantial potential for shaping the future of nuclear energy generation. The SMART (System-integrated Modular Advanced Reactor) is a small modular reactor, moderated and cooled by pressurized water, developed by the Korea Atomic Energy Research Institute (KAERI), with a thermal power output capacity of up to 330 MWt. It has already been licensed, and two units are set to be constructed in Saudi Arabia in the near future. The objectives of the present work are to model the main components of the SMART reactor using the RELAP5 MOD 3.3 thermal-hydraulic analysis code, widely employed in the licensing stages of power and research reactors, and verifying the modeling under steady-state operating conditions and evaluating the reactor's behavior during transient situations. The results from steady-state simulations were compared to reference data and showed good agreement with the expected values, within the acceptable error margins found in literature. The analysis of pressure drop in the primary system, as well as the temperatures of fuel, gap, cladding, and coolant, yielded consistent results within the expected ranges. Additionally, the results obtained from transient simulations are also presented and discussed in this work, providing a comprehensive view of the reactor's behavior under dynamic operating conditions.

Technical Track

Nuclear Thermal-Hydraulics

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