

Evaluation of a Small Subcritical Hybrid Reactor for Transuranic Transmutation

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The hybrid reactor can be considered an attractive actinide burner for transmuting transuranic nuclear waste and reproducing fissile material. Its availability of high-energy neutrons from an external source coupled to the system (such as neutrons produced by spallation reactions or fusion reactions) makes it possible to burn transuranics even in a subcritical operating mode, making such systems inherently safe. Several proposals for hybrid reactors have been studied. However, the most developed concepts are the hybrid fusion-fission reactors (FFH) and the Accelerator Driven Systems (ADS). One of the major obstacles to the construction of these reactors is the development of materials capable of withstanding the hostile environments to which they will be exposed due to the high temperatures and intense bombardment of high-energy particles, conditions created by the technology of the external neutron source. In addition, these machines are designed as large projects, consequently increasing their cost and construction time. Considering overcoming such obstacles, some SMR (Small Modular Reactor) projects present designs favorable for adaptation to a small subcritical hybrid reactor project, such as the Swedish Advanced Lead Reactor (SEALER), a small modular fast neutron nuclear reactor. The lead-cooled core composition and geometry allow for the maintenance of a hardened neutron spectrum, which is necessary for the transmutation by fission of transuranics in reprocessed fuel. Thus, this work aims to evaluate the burnup of reprocessed fuels in a small subcritical hybrid reactor based on SEALER, utilizing a fusion neutron spectrum characteristic of an FFH with plasma parameters obtained from the tokamak reactor ITER. Aspects such as the distribution of the reprocessed fuel in the core, which maximizes the transmutation rate, and the analysis of the performance of the external neutron source will be investigated.

Technical Track

Fusion and Advanced Reactors

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