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Characterization of the Molten Chloride Fast Reactor fuel cycle options

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Molten Salt Reactors, as a whole reactor category, belong to the GenIV reactors. They can be designed as thermal, epithermal of fast systems for variety of applications. Especially the Molten Chloride Fast Reactors (MCFRs) provide very hard neutron spectra and very high neutron economy. Hence, MCFRs can be operated as breeders in the closed U-Pu and Th-U cycles or as breed-and-burn reactors in open U-Pu fuel cycle. This high fuel cycle performance is, nonetheless, accompanied by unfavorable fuel salt transparency for neutrons and results in bulky cores.
In this paper, several operating modes of MCFR are simulated, analyzed and characterized. The EQL0D routine, developed for this purpose at Paul Scherrer Institut, is applied on several fuel cycle scenarios. The major evaluated parameters are the actinide mass balance, core size, neutron spectrum, achievable burnup and radiotoxicity generated per unit of power.
The results show that breeding in MCFRs is possible in both Th-U and U-Pu closed cycles. However, the Th-U cycle provides much lower kinf and results in much bigger core. The breeding in closed U-Pu cycle is possible, and the core size is comparable to the fast fluoride salt reactor operated in the Th-U cycle. The breed-and-burn cycle in MCFRs is possible. Nevertheless, the tight neutron economy require minimization of neutron leakage and the core is thus extremely large. The dependency of core size on fuel cycle parameters like: refueling rate, fissile material share in the feed, or presence of blankets is also analyzed.

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