

Neutronic Study on Safety Characteristics of Fast Spectrum Stable Salt Reactor SSR (Stable Salt Reactor)

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This is a preliminary investigation of safety characteristics of the Stable Salt Reactor (SSR), which is a fast-spectrum molten salt reactor proposed by Moltex Energy. The reference Moltex fuel composition and other publicly released information have been utilized in this work. Regarding the liquid salt fuel, two more TRU (transuranics) compositions are also considered for improved core performances. Since the SSR concept adopts an on-power refueling scheme, a pseudo-equilibrium state was envisioned based on the linear reactivity model. It was found that reactivity change induced by withdrawal or insertion of fuel assembly could exceed 2 \$, which insinuates possible safety or operational issues pertaining to the on-power refueling scheme that has not yet been thoroughly investigated. This work finds that the coolant temperature coefficient (CTC) is clearly positive ~ 2 pcm/K, the Doppler effect of the fuel salt is ~ -0.5 pcm/K and its temperature-dependent expansion coefficient is about -10 pcm/K, leading to fuel temperature coefficient (FTC) of the SSR to be around -10.5 pcm/K. Through point kinetic analyses coupled with a simplified lumped heat balance model, the transient behavior of the SSR system was estimated based on the evaluated temperature coefficients of the reactivity. Although the change in the reactivity is expected to be significant, the feasibility of on-power refueling strategy for the SSR has been found. All of the neutronic calculations were performed using the SERPENT 2 Monte Carlo code with nuclear data library ENDF/B-VII.1.

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