Online Processing System for Molten Salt Reactors

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In a net-zero carbon energy future, advanced nuclear reactors will help satisfy growing energy demand. Among promising advanced nuclear reactor concepts, Molten Salt Reactors (MSRs) have high potential due to high outlet temperatures, fuel utilization, and processing capabilities. While operating MSRs, certain fission and transmutation products are controlled using fuel-salt processing. Traditionally, processing in MSRs is performed offline in batches — a portion of the fuel salt is (i) diverted from the main fuel-salt line, (ii) processed in isolation, and (iii) re-combined with the main fuel line. Instead of offline processing, online processing operates on the entirety of the fuel-salt. In offline processing, the equilibrium concentrations of products is limited by the portion of the fuel-salt diverted. However, in online processing, the equilibrium concentrations can be much lower as all of the fuel-salt is operated on. Through online processing, the lower concentrations extended component lifetime, improve neutron economy, and enable load following with dramatic power differentials. Our design uses the Molten Salt Breeder Reactor (MSBR) as a template and implements various elements to enable online processing and improve reactor performance. Through our design changes, we control noble metals plate-out, increase thermal efficiency, and reduce tritium levels.