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# Implications of Fuel Reloading in Heterogeneous Thorium-Based Fuel Designs for Improved Fuel Cycle Characteristics

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**Abstract :** Fuel models render a reduction in BOL when thorium is added to a reactor core. Thorium emulates the role of a fertile poison, and is beneficial for reducing beginning of cycle (BOC) excess reactivity. In spite of the build-up of 233U over the duration of a fuel cycle, the effects of fuel reloading have a significant impact on fuel viability, especially in the case of heterogeneous thorium-based fuels. The most common practice of compensating for the reduction of BOC reactivity is the addition of fissile isotopes (uranium fuel with increased enrichment or plutonium). This study introduces a heterogeneous thorium-based fuel with minimal fissile isotope additions. A pseudo reloading scheme was developed for numerical simulations of an infinite reactor based on the North-Anna 1 reactor operating in Virginia, USA. Use of this reloading pattern allows new thorium-based fuel to be loaded into the reactor model as part of a phasing in strategy at the end of any conventional reactor cycle. Results demonstrate the effects of thorium-based fuel on fuel cycle characteristics such as fuel cycle length, neutron economy and material matrix. Application of the above mentioned approach delivered promising results and presents a heterogeneous thorium-based fuel which could replace conventional fuel of typical, currently operating (or future) reactors without the need for expensive reactor redesign or fuel recycling strategies.

**Keywords :** nuclear fuel, nuclear characteristics, nuclear fuel cycle, thorium-based fuel, heterogeneous design, fuel reloading
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