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Nuclear Characteristics of a Heterogeneous Thorium-Based Fuel Design Aimed at Increasing Fuel Cycle Length of a Typical PWR

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Abstract : Heterogeneous thorium-based fuels have been proposed as an alternative for conventional reactor fuels and many studies have shown promising results. Fuel cycle characteristics still have to be explored in detail. This study investigates the use of a novel thorium-based fuel design aimed at increasing fuel cycle length of a typical PWR with an explicit focus on thorium- uranium content, neutron spectrum, flux considerations and neutron economy.As nuclear reactions are highly dependent on reactor flux and material matrix, analytical and numerical calculations have been completed to predict the behaviour of the proposed nuclear fuel. The proposed design utilizes various ratios of thorium oxide and uranium oxide pellets within fuel pins, divided into heterogeneous sections of specified length. This design renders multiple regions with unique characteristics. The goal of this study is to determine and optimally utilize these characteristics. Proliferation considerations result in the need for denaturing of heterogeneous regions, which renders more unique characteristics, these aspects were examined in this study. Finally, the use of fertile thorium to emulate a burnable poison for managing excess BOL reactivity has been investigated, as well as an option for flux shaping in a typical PWR.

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