AN ASSESSMENT OF THERMAL-SPECTRUM TRANSMUTATION SYSTEMS

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Abstract

Spent nuclear fuel (SNF) is currently stored in shielded temporary storage facilities near the nuclear power stations where it was generated. Temporary, at-reactor, storage of SNF is threatening the continued utilization of nuclear power in the US, while presenting a potential terrorist target. The US Department of Energy has recently recommended that Yucca Mountain be developed as the first US permanent geologic repository for high-level radioactive waste at a projected cost of 57 B$ or ~800 $/kg of nuclear material. The US Advanced Fuel Cycle Initiative (AFCI) Program has been investigating the economic, social, and environmental viability of sub-critical accelerator-driven systems (ADS) and fast-spectrum critical reactors (FR) for transmuting the hazardous long-lived components of SNF. The overarching goal of the program has been to reduce the number and cost of future repositories. However, the times required for the development and deployment of a Generation-IV fast-spectrum transmuter push the benefits of transmutation half a century into the future. The desire to reap a more immediate benefit forces the consideration of transmutation in a readily available technology, *i.e.*, thermal spectrum reactors. Burning plutonium as mixed uranium-plutonium oxide (MOX) in advanced thermal-spectrum light water reactors (ALWRs) partially addresses the proliferation concerns of SNF, but has not been shown to impact significantly the total SNF actinide inventory. This study examines recycling the minor actinides in ALWRs in an inert matrix fuel (IMF). The NFCSim code is used to model the US reactor fleet plus new reactor deployments that meet an exogenous demand for nuclear power. Repository impact is measured by waste mass, instantaneous and integrated heat production, and toxicity. Performance will be compared to the once-through cycle and transmutation in a fast spectrum burner. Transmutation studies such as this one are intended to provide policy makers with options for resolving the issues in long-term nuclear-waste.