

NUCLEAR ENERGY UNIVERSITY PROGRAMS

Maximum Fuel Utilization in Fast Reactors without Chemical Reprocessing

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Abstract

The objective of this study is to assess the feasibility of designing fast reactor cores to achieve burnups significantly higher than 100 GWd/tHM without reliance on chemistry-based processes (including electro-chemical processes) for fuel recycling. The simplified recycling process proposed has two functions: 1) to remove the gaseous and volatile fission products and 2) to replace the clad. This will relieve the two most limiting design constraints on the burnup attainable from fast reactor fuel in a single recycle: radiation damage to the clad and gaseous fission products pressure buildup. The addition of depleted uranium makeup fuel in this recycling process is an added benefit. The team will design three cores to operate with the simplified recycling fuel cycle:

- A 1000 MWth sodium-cooled core of the dimensions typically being considered for the advanced burner reactor (ABR).
- A 4000 MWth sodium-cooled core similar to the Russian BN-1800 reactor. Having a significantly larger core volume, the leakage probability from this core is smaller than from the 1000 MWth ARR-like core, and the possible number of recycles will be larger. The net result will be a higher cumulative discharge burnup using the MuRLiP fuel cycle.
- A 4000 MWth sodium-cooled core that is designed to have the minimum practical neutron leakage probability and, hence, to offer the maximum possible cumulative discharge burnup. A core of such dimensions has recently been proposed by Intellectual Ventures (IV) LLC for establishing a once-through breed-and-burn type fast reactor fed with depleted uranium. Unlike that design, this project's core will not exceed current radiation damage constraints and is expected to offer higher cumulative discharge burnup). Design approaches to provide acceptable void coefficients will be thoroughly explored.