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Accelerated Testing of Fast Reactor Fuel in the Advanced Test Reactor

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Idaho National Laboratory has a long and internationally recognized history of performing irradiation testing of advanced fast reactor fuels in the Experimental Breeder Reactor II (EBR-II) and the Advanced Test Reactor (ATR). Since EBR-II's decommissioning in the early 1990's, irradiation testing has been exclusively performed in ATR. The testing of fast reactor fuels in ATR is challenging given its thermal neutron spectrum and coolant temperatures far below those prototypic of fast reactors. Researchers have overcome these obstacles through the use of Cadmium shrouds which attenuate all thermalized neutrons and an experiment design that fosters fuel and cladding temperatures prototypic of fast neutron reactors. Although this design has successfully demonstrated temperatures and temperature gradients that closely mimic those seen in fast reactors, irradiation performance is highly sensitive to fabrication tolerances and the time requirements necessary for high fuel burnup, where irradiation performance data of fast fuel is lacking, are significant. This work summarizes two novel experiment designs and their associated physics analyses for testing fast reactor fuels in ATR; an accelerated irradiation experiment and a fast spectrum experiment. The accelerated irradiation experiment does not utilize a Cadmium shroud and has been shown to triple the burnup rate, yet still yields temperatures and radial power profiles prototypic of fast reactor fuels. The fast spectrum experiment utilizes a booster fuel element that hardens the incident neutron spectrum and also yields temperatures and radial power profiles prototypic of fast reactor fuels. These experiment designs efficiently reduce irradiation time requirements, are more economical, and significantly increase ATR throughput. Fast reactor experiments that capitalize on these designs expedite irradiation performance data for fast reactor fuels and provide information invaluable to fuel performance modeling and simulation validation over a wide range of parameters.

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