NUCLEAR ENERGY RESEARCH INITIATIVE

Utilization of Minor Actinides as a Fuel Component for Ultra-Long Life VHTR Configurations: Designs, Advantages, and Limitations

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Collaborators: None

Related Program: AFCI

Project Description

This project will assess the advantages and limitations of using minor actinides as a fuel component to achieve ultra-long life Very High Temperature Reactor (VHTR) configurations. Researchers will consider and compare the capabilities of pebble-bed and prismatic core designs with advanced actinide fuels to achieve ultra-long operation without refueling. Since both core designs permit flexibility in component configuration, fuel utilization, and fuel management, it is possible to improve fissile properties of minor actinides by neutron spectrum shifting through configuration adjustments. Consequently, small reactivity swings will be sustained in the VHTR configurations with minor actinides over a prolonged irradiation period yielding high levels of burn-up.

This project will study advanced actinide fuels, which could reduce the long-term radio-toxicity and heat load of high-level waste sent to a geologic repository and enable recovery of the energy contained in spent fuel. The ultra-long core life approach would reduce the technical need for additional repositories and would improve marketability of the Generation IV VHTR by allowing worldwide deployment, including in developing countries. Utilizing minor actinides would facilitate development of new fuel cycles and support fuel supply sustainability.

Work Scope

The work consists of six tasks:

- Develop whole-core/system models with explicit multi-heterogeneity treatments.
- Develop benchmark test problems to compare with experimental data.
- Validate and verify the VHTR models.
- Analyze uncertainty effects on VHTR performance characteristics.
- Analyze configuration variation capabilities to achieve ultra-long operation without refueling, maximize burn-up levels, and minimize reactivity swings.
- Complete control, dynamics, safety, and proliferation-resistance studies of ultra-long life VHTR configurations with advanced actinide fuels.

Researchers will also evaluate ex-core fuel cycle segments and study the impacts of increasing burn-up levels on the generated radioactivity.