NUCLEAR ENERGY RESEARCH INITIATIVE

On-Line Fuel Failure Monitor for Fuel Testing and Monitoring of Gas Cooled Very High Temperature Reactors

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Project Number: 05-054

Collaborators: None

Related Program: AFCI

Project Description

This project will devise an accurate approach to detect failures of TRISO (Tristructural Isotropic) fuel based on measurements of fission gas activity released into the effluent stream. In the gas cooled Very High Temperature Reactor (VHTR), the fuel is made up of TRISO microspheres composed of a UO_2 kernel surrounded by a porous pyrolytic graphite buffer, an inner pyrolytic graphite layer, a silicon carbide (SiC) coating, and an outer pyrolytic graphite layer. The layer/coating system that surrounds the UO_2 kernel acts as the containment and main barrier against the environmental release of radioactivity. However, due to hostile in-core conditions (e.g., high temperature, fast neutron flux, etc.), it is anticipated that a certain number of TRISO microspheres will fail during reactor operation. To ensure compliance with radiological and safety requirements, it is essential to detect any fuel failure at the earliest stage possible.

The aim of this project is detection of a single failed TRISO particle per testing capsule. Researchers believe that fuel failure rates on the order of 10^{-5} are detectable and that the detection method will provide insight into the failure mode. Various detection methods will be studied to differentiate the minute fission product signal from background. As part of the fuel development program for the VHTR, researchers will conduct fuel failure experiments at the Advanced Test Reactor of Idaho National Laboratory (INL). Methods and instrumentation developed by this project are expected to be applicable to on-line fuel failure monitoring of VHTRs.

Work Scope

Researchers will study the option of performing on-line measurements using gamma-ray spectrometers that are placed along the path of the coolant flow. They will also consider sampling the main flow and collecting the appropriate fission products in an optimal environment to perform signal-to-noise measurements. In both cases, specialized instruments, measurement techniques, and data processing methods will be required to discern minimum detectable activity limits. The project tasks will include:

- Calculate isotopics of TRISO microspheres and estimate fission product activity released from failure of a single microsphere.
- Examine response of various detectors and analyze the resulting spectra.

- Design, construct, and test a prototype gas extraction system coupled to various detectors.