NUCLEAR ENERGY RESEARCH INITIATIVE

Advancing the Fundamental Understanding and Scale-up of TRISO Fuel Coaters via Advanced Measurement and Computational Techniques

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Program Area: Generation IV

Collaborators: None

Project Description

Defect-free tri-isotropic (TRISO) fuel particle coating is critical for the future use of nuclear energy produced by advanced gas reactors (AGRs). The quality of coating applied to the fuel kernels is impacted by the hydrodynamics, solids flow field, and flow regime characteristics of the spouted bed coaters, which are influenced by design parameters and operating variables. This work is to advance the fundamental understanding of the hydrodynamics of TRISO fuel particle spouted bed coaters by investigating the effect of design and operating variables, evaluating the reported dimensionless groups as scaling factors, and establishing a reliable scale-up methodology that accounts for the effects of particle-particle interactions and thermal expansion of the gas phase. Researchers will also develop a non-invasive measurement technique based on gamma ray densitometry that can be used for coater process monitoring to ensure proper performance and operation and to facilitate the developed scale-up methodology.

To achieve the objectives, researchers will measure critical parameters of the spouted bed using gamma ray computed tomography and computer automated radioactive particle tracking, as well as gas dynamic measurement techniques, optical probes, and pressure transducers. These measurements will be used as benchmark data to evaluate and validate the computational fluid dynamic (CFD) models (two-fluid and discrete particle models) and their closures. The validated CFD models and closures will be used to develop a methodology for scale-up, design, and hydrodynamic similarity and to further optimize the process performance of TRISO coaters under different conditions.

Workscope

This project will perform the following primary tasks:

- Develop on-line and non-invasive techniques for process monitoring and measurement
- Conduct Gamma Ray Computed Tomography (CT), pressure drop fluctuation, and optical probe measurements and investigation
- Perform Computer Automated Radioactive Particle Tracking (CARPT) measurements
- Perform gas dynamic measurements and investigations
- Conduct computational fluid dynamics (CFD) studies
- Simulate real TRISO fuel particle coaters using CFD
- Investigate mimic TRISO fuel particle coaters using the above techniques and models