UTILIZING THE SLOWING-DOWN-TIME TECHNIQUE FOR BENCHMARKING NEUTRON THERMALIZATION IN GRAPHITE

T. Zhou, A. I. Hawari*, B. W. Wehring

Department of Nuclear Engineering, North Carolina State University, Raleigh, NC 27695, USA

E-mail *ayman.hawari@ncsu.edu*

ABSTRACT

Graphite is the moderator/reflector in the Very High Temperature Reactor (VHTR) concept of Generation IV reactors. As a thermal reactor, the prediction of the thermal neutron spectrum in the VHTR is directly dependent on the accuracy of the thermal neutron scattering libraries of graphite. In recent years, work has been on-going to benchmark and validate neutron thermalization in "reacor grade" graphite. Monte Carlo simulations using the MCNP5 code were used to design a pulsed neutron slowing-down-time experiment and to investigate neutron slowing down and thermalization in graphite at temperatures relevant to VHTR operation. The unique aspect of this experiment is its ability to observe the behavior of neutrons throughout an energy range extending from the source energy to energies below 0.1 eV. In its current form, the experiment is designed and implemented at the Oak Ridge Electron Linear Accelerator (ORELA). Consequently, ORELA neutron pulses are injected into a 70cm x 70cm x 70cm graphite pile. A furnace system that surrounds the pile and is capable of heating the graphite to a centerline temperature of 1200 K has been designed and built. A system based on U-235 fission chambers and Li-6 scintillation detectors surrounds the pile. This system is coupled to multi-channel scaling instrumentation and is designed for the detection of leakage neutrons as a function of the slowing-down-time (i.e., time after the pulse). To ensure the accuracy of the experiment, careful assessment was performed of the impact of background noise (due to room return neutrons) and pulse-to-pulse overlap on the measurement. Therefore, the entire setup is surrounded by borated polyethylene shields and the experiment is performed using a source pulse frequency of nearly 130 Hz. As the basis for the benchmark, the calculated time dependent reaction rates in the detectors (using the MCNP code and its associated ENDF-B/VI thermal neutron scattering libraries) are compared to measured values. At room temperature, the results indicate a deviation of nearly 20%-30% in the thermal energy range. This deviation is attributed to the inadequate representation of graphite in the current data libraries.