Advancements in Validation of TSLs through Inelastic Neutron Scattering and Transmission Measurements

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Abstract:

Historically, the free gas approximation has been used to treat the thermal scattering of neutrons with energies below a few electron-volts (eV) in unevaluated materials. However, this method inadequately reproduces neutron scattering at these energies. Until recently, only a limited number of materials had available thermal scattering law (TSL) files/libraries in the ENDF nuclear data libraries in this energy range. With advancements in atomistic modeling techniques, such as molecular dynamics, ab-initio molecular dynamics, and density functional theory, TSL libraries have become available for many more materials. This is particularly relevant due to the rising interest in several advanced reactor systems that require novel moderator and reflector materials.

While quasi-integral and integral benchmarks have been designed to validate historically important moderator materials (such as light water and polyethylene), there is currently a lack of standard validation methods for TSLs, especially when multiple conflicting TSLs exist. To address this issue, the Oak Ridge National Lab Nuclear Data group has been working on utilizing inelastic neutron scattering (INS) measurements combined with transmission (i.e., total cross section) measurements to evaluate and validate TSLs for different materials. We plan to demonstrate how this method has worked on materials such as polyethylene, lucite, and polystyrene. In addition, we will compare the newly created libraries to ENDF libraries for these materials and explain why integral benchmarks should not be used for validation when multiple TSLs exist.

[*]*This work was supported by the Nuclear Criticality Safety Program, funded and managed by the National Nuclear Security Administration for the Department of Energy.*