Neutron Multigroup Constant Sets of Moderator Materials for Design of Low-Energy Neutron Sources

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For design assessment of low-energy neutron sources, neutron multigroup constant sets(energy-averaged cross sections) are developed, which consist of 36 sets of multigroup constants for liquid ^{4}He, H_2, D_2, CH_4, H_2O and D_2O and solid CH_4 at many different temperatures. The neutron energy range between 0.1 μeV and 10 MeV is divided into 140 energy groups at equal logarithmic intervals. The angular distribution of scattered neutrons is represented by the expansion in Legendre polynomials up to order 3. The multigroup constants at energies below 10 eV are generated using physical models of a double-differential scattering cross section for the moderator materials, which are newly developed for describing low-energy neutron scattering in terms of the general considerations of molecular dynamics and structures inherent in liquid and solid phases.

Most of the calculated cross-section results are compared with many experimental measurements, both double-differential and total, at various material temperatures and neutron energies. Availability of the constant sets are demonstrated by the multigroup neutron transport analyses for production of ultra-cold($\sim$ 0.3 μeV), cold($\sim$ 2 meV) and thermal($\sim$ 25 meV) neutrons. Features of the multigroup constant sets for each moderator material and typical results of low-energy neutron production will be reported in the presentation.