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Neutron Production from Spallation Reactions

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Abstract

Target systems for spallation neutrons are designed to enhance production and neutronic efficiencies as well as to investigate a target cooling system. Lead and tungsten are chosen for target materials. Three target systems (solid cylinder, solid disc array, disc-array in cylindrical shell) for applications to a subcritical fast reactor are introduced to investigate neutronic characteristics of each target geometry. By making use of LCS simulation code, neutron production and leakage rates are calculated for each target design. The cost effective neutron yields turns out to be ~27 n/s at 1.3 GeV for solid lead target, and ~24 n/s at 1.5 GeV for solid tungsten target, per an incident proton. Single proton from 1 GeV accelerator deposits total heat of 588 MeV in solid lead target and 600 MeV in solid tungsten target. As far as spallation neutron yields and heat removal system design are concerned, lead target system has advantage of the tungsten target. By adjusting size of solid lead target, the optimal radius and height of the target are found to be ~11 cm, and ~50 cm, respectively. Energy spectra of neutron fluxes of the tungsten target system shows much better performance than those of lead target in the energy range of lower than 1 MeV. Relation of the size of target and axial distributions of neutron fluxes is discussed in this paper. Also, we present a method to reduce leakages through top and bottom surfaces by adjusting a gap distance of disc-array type target system. Our neutronic results obtained from lead target can also be applied to liquid lead target system except for heat removal mechanisms.