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Measurement and Simulation of Axial Neutron Flux Distribution in Dry Tube of KAMINI Reactor

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Abstract : A new dry tube (DT) has been installed in the tank of KAMINI research reactor, Kalpakkam India. This tube will be used for neutron activation analysis of small to large samples and testing of neutron detectors. DT tube is 375 cm height and 7.5 cm in diameter, located 35 cm away from the core centre. The experimental thermal flux at various axial positions inside the tube has been measured by irradiating the flux monitor (^{197}Au) at 20kW reactor power. The measured activity of ^{198}Au and the thermal cross section of ^{197}Au (n,γ) ^{198}Au reaction were used for experimental thermal flux measurement. The flux inside the tube varies from 10^9 to 10^{10} and maximum flux was (1.02 ± 0.023) x10^{10} n cm^{-2}s^{-1} at 36 cm from the bottom of the tube. The Au and Zr foils without and with cadmium cover of 1-mm thickness were irradiated at the maximum flux position in the DT to find out the irradiation specific input parameters like sub-cadmium to epithermal neutron flux ratio (f) and the epithermal neutron flux shape factor (α). The f value was 143 ± 5, indicates about 99.3% thermal neutron component and α value was -0.2886 ± 0.0125, indicates hard epithermal neutron spectrum due to insufficient moderation. The measured flux profile has been validated using theoretical model of KAMINI reactor through Monte Carlo N-Particle Code (MCNP). In MCNP, the complex geometry of the entire reactor is modelled in 3D, ensuring minimum approximations for all the components. Continuous energy cross-section data from ENDF-B/VII.1 as well as S (α, β) thermal neutron scattering functions are considered. The neutron flux has been estimated at the corresponding axial locations of the DT using mesh tally. The thermal flux obtained from the experiment shows good agreement with the theoretically predicted values by MCNP, it was within ± 10%. It can be concluded that this MCNP model can be utilized for calculating other important parameters like neutron spectra, dose rate, etc. and multi elemental analysis can be carried out by irradiating the sample at maximum flux position using measured f and α parameters by k_0-NAA standardization.

Keywords : neutron flux, neutron activation analysis, neutron flux shape factor, MCNP, Monte Carlo N-Particle Code
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