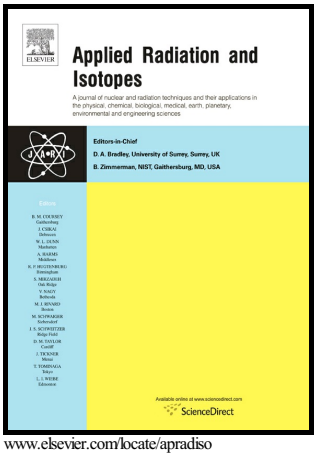

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ABSTRACT

As an iron is the main structural component of nuclear power plants as well as future fusion power plants, the validation of neutron incident data libraries of iron is a must. Presented paper fits into ongoing validation activities and presents measuring neutron leakage spectra in the 0.1-1.0 MeV region from iron sphere of 100 cm in diameter by hydrogen proportional detectors. The experimental result is compared with ENDF/B-VII.1, JEFF-3.2 and CIELO nuclear data libraries. No library reasonably well describes whole region under study. Furthermore, elastic and inelastic XS sensitivity analysis for all iron isotopes was carried out. ^{54}Fe isotope elastic XS influence is comparable with ^{56}Fe XS influence up to 0.8 MeV. ^{57}Fe isotope elastic XS is significant in the region of 0.14-0.15 MeV. Additionally, there are large differences among libraries in both elastic and inelastic XS for ^{57}Fe. Furthermore, it was found that ^{58}Fe isotope XS has negligible influence on the results. As a neutron source, ^{252}Cf with initial emission rate of 9.53E8 n/s was used in this experiment.

Keywords: natural iron isotopes, cross section, natural iron sphere, ^{252}Cf

1. Introduction

As an iron is one of the most important materials in the experimental accelerator facilities and in nuclear technology for reactor pressure vessels (Košťál 2012) and also internal structures (Košťál 2014). There is a high priority focus on iron cross section (hereafter XS) estimation and validation. The main component in a natural iron is ^{56}Fe isotope. However, in the neutron transport through thicker layers of iron, the XS influence of other minor isotopes starts to be significant. This is assessed by the sensitivity analysis of the influence of elastic and inelastic XS of ^{54}Fe, ^{56}Fe, ^{57}Fe and ^{58}Fe in natural iron. It is motivated by the fact that there are significant differences in evaluated inelastic scattering for iron. The difference in the inelastic scattering among the libraries mainly come from experimental data used (Chadwick 2014). Furthermore, the elastic to inelastic ratio is most influential and most simple type of XS variation.

To support the analysis, the neutron flux in 0.1-1.0 MeV region was measured by hydrogen proportional spherical detectors for the case when neutrons leak the natural iron sphere of a diameter 100 cm with ^{252}Cf neutron source placed in its center. Moreover, calculations with different libraries were compared against the experimental data. However, this measurement involving the iron sphere is not sensitive to the scattering angular dependence because of high rate of multiple scatterings which occur in the big sphere.

An encapsulated ^{252}Cf was used as a neutron source in the experiment. The ^{252}Cf has a half-life of 2.645 years, 3.09% of the isotope decays by spontaneous fission releasing approximately 3.7 neutrons. The emission of the source was 9.53E8 n/s on August 13th 2015 according to the data in Certificate of Calibration involving manganese sulphate bath. Emission of the source was approximately 7.0E8 n/s during the experiment.