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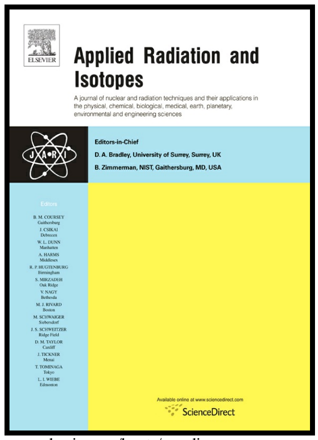

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Benchmark integral neutron experiments for Fe, Be and C with DT neutron by liquid scintillation detector

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Abstract: The measurements of iron, beryllium and carbon sphere neutron leakage spectra using BC501A detector by DT neutron source are presented. The experiments were carried out in Institute of Nuclear Physics and Chemistry (INPC), China. Neutron leakage spectra in a wide energy range at angles of 0˚ and 30˚ from the direction of incident deuteron beam were obtained. The results show the leakage neutron flux decreases notably with the spherical shell increasing when neutron energy >10MeV. When neutron energy <6MeV the leakage neutron distribution tends to lower energy side with the shell increase. The total uncertainty evaluation of the neutron spectra is also provided: in the high-energy parts the uncertainty is about 5 - 7%, while in the low-energy parts the uncertainty is about 7 - 9%. In order to compare the experiment results a Monte-carlo calculation was made using the MCNP5 Code with the ENDF/B-VII.1 nuclear data files.

Key words: benchmark experiment; DT neutron; leakage neutron spectra; uncertainty evaluation

1. Introduction

The transport of DT 14-MeV neutrons through materials is of great importance in many fields. Iron is widely used in the nuclear engineering and design. In the future fusion reactors materials would be irradiated by high flux neutrons with energy range from thermal to tens of MeV (Jordanova et al., 2001). For the good radiation shielding and mechanical quality iron is an important candidate material in fusion reactors. Beryllium is an important material in fission and fusion nuclear technology for multiplying neutrons in the core of fission research reactors and in the blankets of D–T fusion reactors (Y. Nie et al., 2016). Carbon is an effective neutron moderating material in fusion reactors, which neutron data is deeply concerned by the researchers (Jordanova et al., 1999). As a result, Neutron energy spectra data on iron, beryllium and carbon are required to be more accurate. Benchmark integral neutron experiment plays an important role in the obtaining and evaluating neutron spectra data. Neutron data in nuclear library also should be verified by benchmark integral experiment. In present study several researchers have performed Benchmark experiments to obtain the neutron spectra for these three materials. Jansky B et al. (2014) used iron spheres to measure neutron spectra with a ^{252}Cf neutron source by hydrogen in a proportional spherical detector (HPD) and stilbene scintillator detector (SSD). Konno C et al. (2011) used iron slabs to measure neutron angular distribution and leakage angular neutron spectra by Time-of-Flight (TOF). Hagiwara M et al. (2009) have performed benchmark experiments of neutron penetration through iron shielding for hundreds of MeV quasi-monoenergetic neutrons. For beryllium and carbon, a series of integral experiments have been conducted for qualifying and validating nuclear data. Some of these experiments, however, did not obtain the neutron spectra

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