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Optimization study of B_4C filter thickness for shifting to fast spectrum at experimental position in NRAD core

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In order to expand the experimental data contributing to the nuclear data validation of minor actinide, we have a plan to perform integral experiments in the NRAD belonging to the Idaho National Laboratory. In this study, optimization survey for the design of experimental position in the NRAD was carried out to obtain more beneficial experimental data.

Keywords: Integral experiment, Thermal neutron cutoff filter, B_4C

1. Introduction

In the nuclear transmutation system for minor actinides, the nuclear data validation of them is required to reduce the uncertainty in the associated experiments. The Idaho National Laboratory has proposed to perform measurements of the fission rate ratio and sample reactivity worth under a wide range of spectral indices created using several types of thermal neutron shielding filters. The samples and filters are placed in an experimental position in the Neutron RADiography (NRAD) reactor. In this study, the optimization of the B_4C filter thickness was conducted to acquire the high-accuracy and the beneficial experimental data.

2. Evaluation method for optimization

The thickness of the B_4C filter is surveyed for optimization in terms of ability to cut out the thermal neutrons and fabrication accuracy using MCNP 6.1 [1] with the nuclear data library based on ENDF/B-VII.1 [2]. First, the total flux and energy wise sensitivity coefficient of fission reaction rate with respect to neutron energy spectrum (S) at the experimental position are compared to see the influence to which the filter thickness is changed. Finally, the primary candidate of B_4C filter thickness is discussed with regard for fabrication accuracy.

3. Results・Conclusion

The filter should not be designed thicker than necessary due to the decreased total flux at the experimental position. On the other hand, from the analysis of the relationship of the B_4C filter thickness and the ratio of S of ^{237}Np fission reaction rate with respect to neutron energy spectrum in the fast energy region to that in the all energy region, the thickness of less than 2 mm was discouraged to minimize the impact of the fabrication uncertainty of filter thickness on the evaluation of the measurement result of the fission reaction rate. When the filter was 3 mm or thicker, the ratio of S in the fast energy region was over 99% and nearly saturated. Therefore, the primary candidate for optimized the B_4C filter thickness was 3mm in this study.

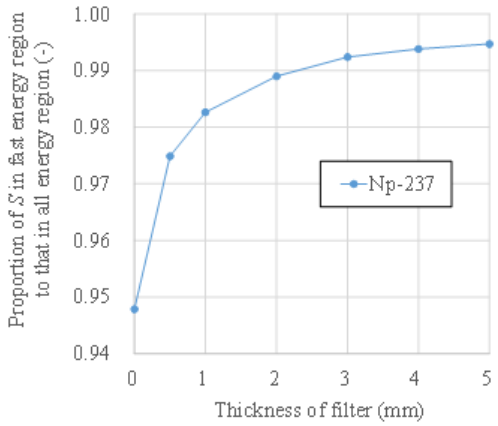

Fig.1 Relationship of the B_4C filter thickness and the percentage of sensitivity coefficient in the fast energy region

[1] J.T. Goorley, et al., Los Alamos National Laboratory, LA-UR-13e22934 (2013).
[2] M.B Chadwick., et al.,. Nucl. Data Sheets. 112 (12), pp. 2887–2996, (2011).