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A comparative study of WIMSLIB group constants processed through NJOY'99 from ENDF/B-VI and JENDL-3.3 for ^{20}Ca, ^{12}Mg, ^{15}P, ^{16}S, ^{14}Si, ^{22}Ti, and ^{23}V

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Abstract

The aim of this paper is the comparative study of WIMS library group constants generated from ENDF/B-VI and JENDL-3.3 evaluated nuclear data files. The WIMSLIB group constants have been generated from ENDF/B-VI and JENDL-3.3 through NJOY'99 for ^{20}Ca, ^{12}Mg, ^{15}P, ^{16}S, ^{14}Si, ^{22}Ti, and ^{23}V. The GROUPR output was processed by WIMSR to produce the WIMSLIB group constants. The parameters compared are slowing down power/lethargy widths, transport cross-section, absorption cross-section and Goldstein–Cohen λ parameters. WIMS library generated from ENDF/B-VI and JENDL-3.3 have good agreement in general but some significant points of disagreement also exist. These observations can be used as inputs for the WIMS update library of TRIGA Mark-II research reactor and also for the ENDF/B-VI and JENDL-3.3 data verification tasks.

Keywords: WIMSLIB; GROUPR; WIMSR; Group constants; NJOY'99; TRIGA

1. Introduction

Concrete shielding outside the reactor tank of TRIGA reactor contains the elements ^{20}Ca, ^{12}Mg, ^{15}P, ^{16}S, ^{14}Si, ^{22}Ti, and ^{23}V. Neutronics calculation related to concrete shielding has not yet been performed. By including the NJOY'99 (MacFarlane and Muir, 1999) processed cross-section data of these elements in the WIMSD-5B (Kulikowska, 1996) library, improved neutronics calculation of TRIGA Mark-II research reactor can be obtained.

The WIMS is one of the most widely used general-purpose thermal reactor analysis code. The users observed several deficiencies of WIMS library:

(i) the cross-section library is based on old nuclear data,
(ii) several nuclides, typical for power and research calculations are absent in the library,
(iii) errors in some of the very important resonance integrals like ^{238}U, and
(iv) absence of the self-shielding effect of resonance scattering cross-section.

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After a development period of 10–15 years, the availability of several recent evaluated improved basic nuclear data files, such as ENDF/B-VI (Rose and Dunford, 1990) and JENDL-3.3 (Shibata et al., 1990), offers the possibility of improving the WIMS data library. In this context it is essential to investigate the group constants generated update the WIMS 69-group cross-section library (Taubman, 1975) from ENDF/B-VI and JENDL-3.3.

The output of the GROUPR module was processed by WIMSR to produce the 69-group format WIMS library for the following isotopes: ^{20}Ca, ^{12}Mg, ^{15}P, ^{16}S, ^{14}Si, ^{22}Ti, and ^{23}V. The parameters those have been compared as slowing down power/lethargy widths, transport cross-section, and absorption cross-section. The ratio of ENDF/B-VI and JENDL-3.3 and the percentage of deviations have been calculated. Major discrepancies in the group constants generated from the mentioned files have been studied for the elements considered. In most of the cases studied the ENDF/B-VI and JENDL-3.3 have good agreement but some points of severe disagreements have been observed. To have a comparative vision for evaluation one needs to have a closer look by the individual element, which follows in the report. Finally it can be concluded that the WIMS library generated from ENDF/B-VI and JENDL-3.3 differ significantly in some of the cases studied. These points of discrepancies need to be carefully addressed and resolved.

2. Data processing method

To process the basic evaluated data of ^{20}Ca, ^{12}Mg, ^{15}P, ^{16}S, ^{14}Si, ^{22}Ti, and ^{23}V from different evaluated nuclear data files into the WIMS 69-group format, the comprehensive nuclear data processing code system, NJOY'99 has been utilized. The scheme followed to generate the multigroup data in WIMS library format is presented in Fig. 1.The MODER module is used to convert ENDF, PENDF and GENDF tapes from the NJOY blocked-binary mode (BCD, EBCDIC, ASCII, etc.) and vice versa. The RECONR module reconstructs the ENDF/B-VI and JENDL-3.3 resonance representations with a unionized energy grid and unifies the interpolation laws so as to obtain a point wise evaluated nuclear data files tape. The BROADR module Doppler broadens the cross-sections.

The UNRESR module is used when self shielded average cross-section for the unresolved energy regions is required. The THERMR module is used to compute thermal scattering cross-sections. The GROUPR module is used to obtain multigroup averages' cross-sections and transfer matrices. Finally the WIMSR is used to prepare data in WIMS library format. The module WILLIE (Trkov and Holubar, 1998) has been used to insert the new data into the WIMSD-5B library. WIMS libraries normally use a standard 69-group structure with 14 fast groups, 13 resonance groups and 42 thermal groups.

3. Data processing details

3.1. General remarks

The materials that were actually processed in this study are mentioned in Table 1.

3.2. Averaging spectrum

For generating the group constants a typical averaging spectrum for light water reactor was used. This EPRI-LWR spectrum built in as one option in NJOY was utilized (Trkov et al., 1993).

3.3. Goldstein–Cohen parameters

The Goldstein–Cohen parameters λ were applied as reported by Aldous (1969).

3.4. Dilution factor grid and temperatures

All the cross-sections for all the isotopes have been obtained at infinite dilution and at room temperature, i.e., $\sigma_0 = 10^{10}$ and $T = 300$ K.