Comparison of Cross Section Data Library for High Temperature using MCNPX

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Abstract

This study describes the procedure to processed cross-section data from ENDF/B-VI for MCNPX library by NJOY-99.396. The generated cross-section (ENDF/B-VI-NJOY) was evaluated by comparison with provided cross-section *endf66b* package derived from ENDF/B-VI (ENDF/B-VI) through calculating the multiplication factor (k∞) of the benchmark problems from the *Handbook of Evaluated Criticality Safety Benchmark Experiments*. In addition, the ENDF/B-VI-NJOY cross section was applied to calculate k∞ value at different burn up of a fuel assembly without burnable absorber (BA) (Gadolinia) and having 8% of BA of Small Module Reactor (SMR) at operating temperature. The results calculated by MCNPX was compared with the results of the same fuel assembly models calculated by two dimensional transport code CASMO-4.

Processing cross section

The code NJOY-99 are used to processed pointwise cross section from ENDF-VI release 6 to ACE format that is used in MCNPX. There are total 9 modules were used for processing cross section as shown in Fig 1. Neutron cross section file of 40 isotopes were generated, these library files were imported to MCNPX library by *xsdir* file.

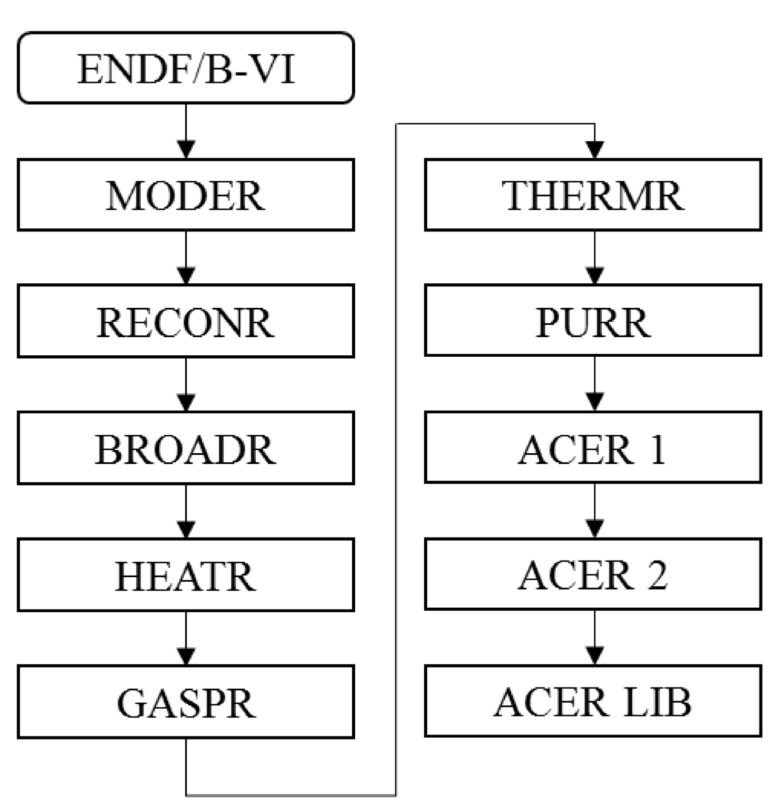

Fig 1. Processing procedure

Verification

Fig 2. Calculated k∞ values compared to benchmark results

Application

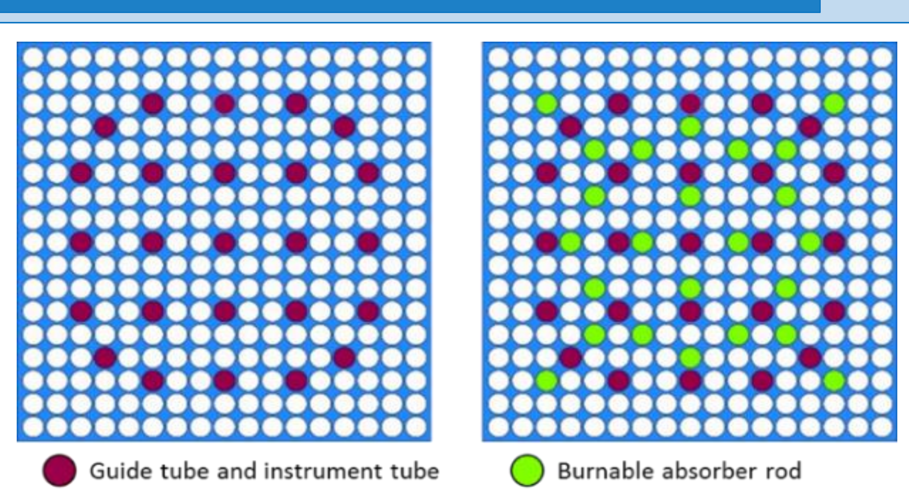

Figure 3. Fuel assembly layout

The ENDF/B-VI-NJOY cross section was applied to calculate the k∞ at different burn-up of a fuel assembly of Smart Module Reactor (SMR) shown in Fig 3. There are two models of fuel assemblies, the first one has no BA rod and the second one has 24 BA rods containing 8 w/o of Gd_2O_3 located octant-symmetry in fuel assembly.

The fuel assembly has 17x17 fuel rod, 24 guide tubes, and one instrumentation tube. The fuel assembly specification is shown in Table 1.

Table 1. Fuel assembly specification

Assembly type	17x17
Fuel material	UO_2
Enrichment of fuel	4.95 %
Cladding material	ZR-2
Coolant/Moderator material	H_2O
Burnable absorber material	Gd_2O_3
Number of BA	24
Fuel rod diameter	0.819 cm
Fuel rod pitch	1.254 cm
Assembly pitch	21.50 cm
Fuel pellet density	10.176 g/cm³
Cladding inner diameter	0.819 cm
Cladding outer diameter	0.950 cm
Guide tube inner diameter	1.140 cm
Guide tube outer diameter	1.220 cm
Active length	200.0 cm
Fuel temperature	960.95 K
Moderator temperature	585.35 K
Cladding temperature	612.00 K

Figure 4 shows the k∞ at different burn-up of the fuel assembly has no BA. For the results calculated by CASMO-4, the k∞ values are lower than others. The k∞ values obtained by MCNPX using ENDF/B-VI cross section are higher at low burnup compare to ENDF/B-VI-NJOY cross section.

For the fuel assembly having BA, the k∞ at different burn-up is shown in Figure 5. The k∞ values calculated by CASMO-4 are also lower than the others. The k∞ values obtained by ENDF/B-VI cross section are higher than results of ENDF/B-VI-NJOY cross section.

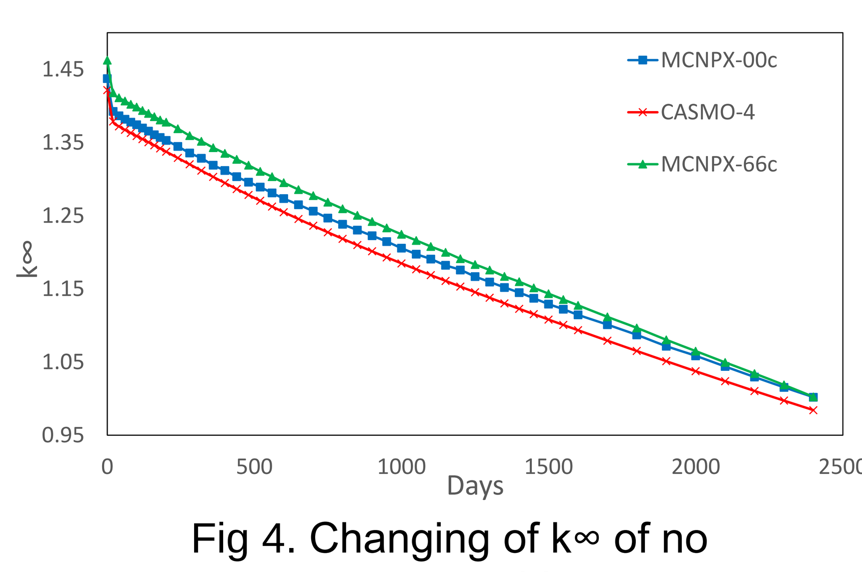

Fig 4. Changing of k∞ of no BA assembly

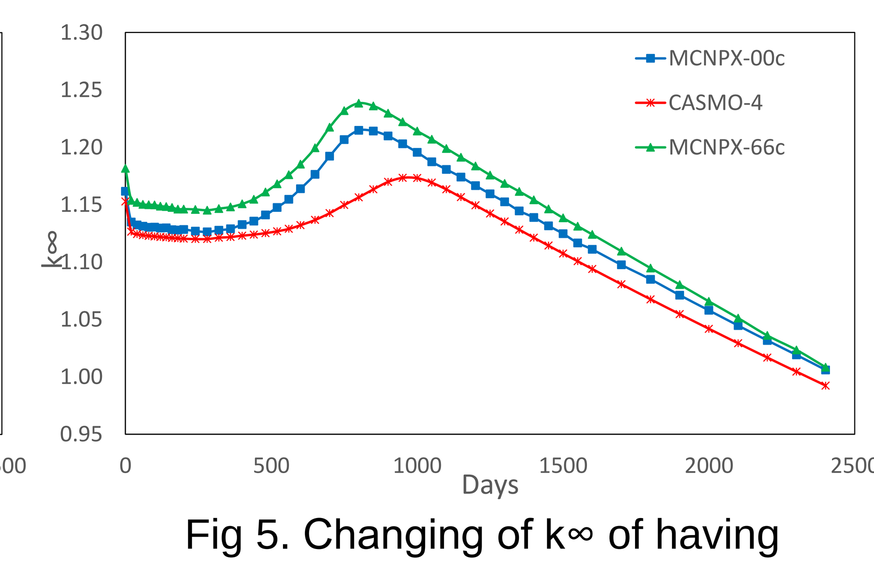

Fig 5. Changing of k∞ of having BA assembly

Conclusions

This study shown the method of customization the cross section library for MCNPX matching the special condition of simulation models. The results from the benchmark problems calculation approved the availability of generated cross section by NJOY-99.396. Through the comparisons, there is a noticeable error between MCNPX results and CASMO-4 results. This error will be investigated in the next studies.

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