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Nuclear heating and damage data in JENDL-5 neutron ACE file/JENDL-5 中性子 ACE ファイルの核発熱、損傷データ

The Japanese Evaluated Nuclear Data Library JENDL-5 was released in 2021. The neutron ACE file of JENDL-5 was mainly produced with the FRENDY2 code, while nuclear heating and damage data were done with the NJOY2016.65 code modified for JENDL-5, and it was released as one of ACE-J50 [1] in 2022. This presentation explains the nuclear heating and damage data in it.

Neutron ACE files have heating numbers and damage production energy cross sections as the nuclear heating and damage data. Note that heating numbers are deduced from KERMA factors and DPA cross sections are produced from damage production energy cross sections. KERMA factors are calculated with two methods: the energy balance method and kinematics method. Original NJOY stores heating numbers from KERMA factors with the energy balance method to ACE files, but the KERMA factors can be negative or too large because of the energy balance problem.

In JENDL-4.0 heating numbers from KERMA factors with the kinematics method were stored to all the neutron ACE files by using modified NJOY99 in order to sidestep the energy balance problem. However the modification of NJOY99 was not adequate, which produced negative probability table (p-table) of heating number. Heating values in PHITS heating calculations by using ACE files with the negative p-table become "NaN"(Not a Number). Thus all p-table data were deleted from neutron ACE files of JENDL-4.0 with negative p-table. Heating numbers from KERMA factors with the kinematics method were stored to all the neutron ACE files in JENDL-5 because of the energy balance problem, by using adequately modified NJOY2016.65, which produced no negative p-table of heating number.

It was known that damage production energy cross sections in neutron ACE files of JENDL-4.0/HE dropped down above 20 MeV because of no energy distribution data of several residual nuclei above 20 MeV in JENDL-4.0/HE [2]. JENDL5 includes energy distribution data of all residual nuclei above 20 MeV, which solves this issue.

Recently Chinese researchers reported that the HEATR module of NJOY had a fatal bug that it calculated KERMA factors and DPA cross section data without multiplying secondary gamma yield when secondary gamma data were stored in File 6 [3]. JENDL-5 was processed with the bug fixed NJOY.

References

[1] https://rpg.jaea.go.jp/main/en/ACE-J50/

[3] S. Kwon et al., J. Nucl. Sci. Technol., 57(2020), 344 –351.

[3] W. Yin et al., Annals of Nuclear Energy, 164 (2021) 108624.

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