

JENDL-4 benchmark for high temperature gas-cooled reactor, HTTR

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Introduction (1/2)

■ Background

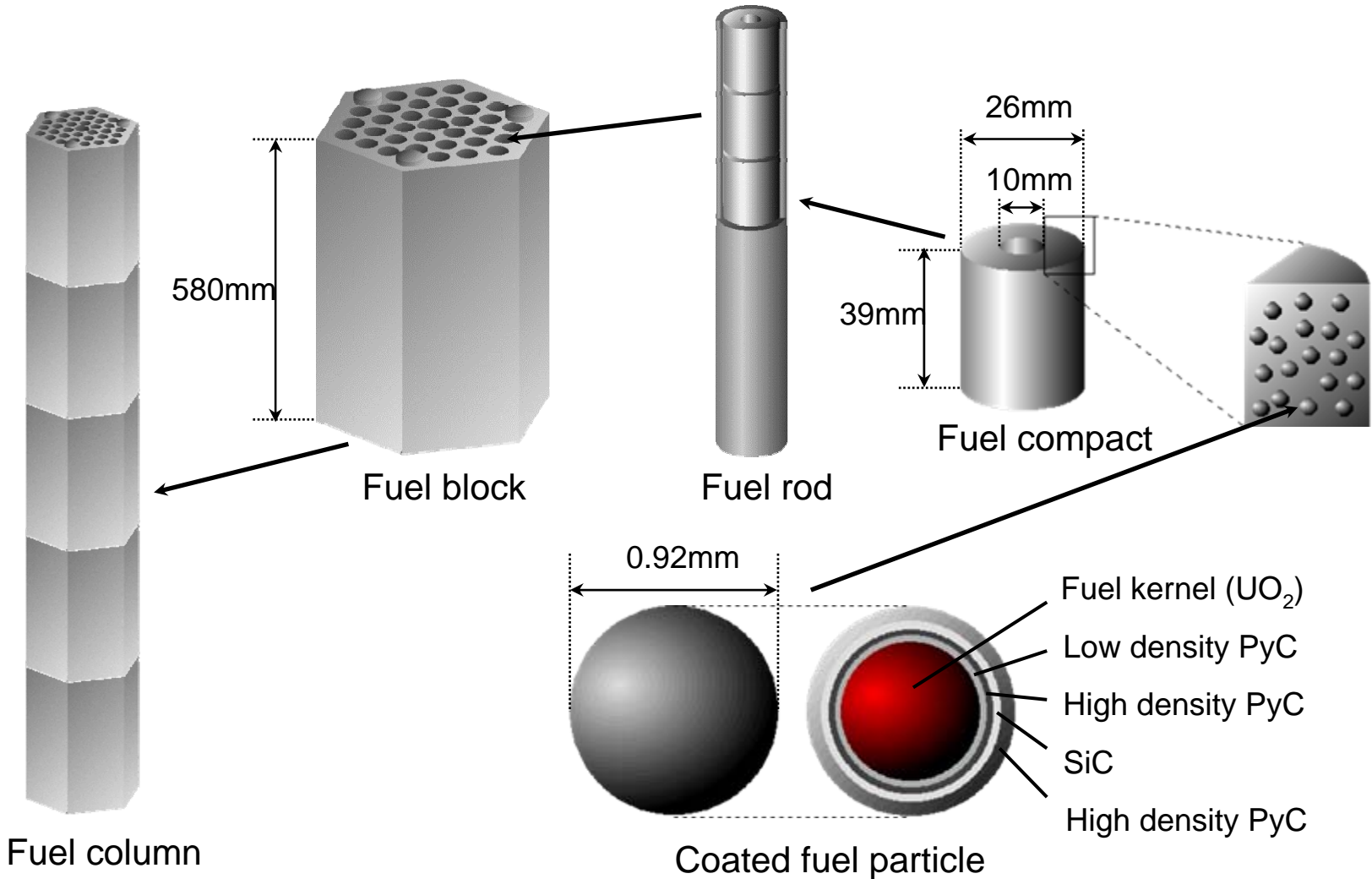
- In the previous study, JENDL-3.3 showed better applicability to the HTTR criticality calculations than ENDF/B-VI.8 or JEFF-3.1, but still overestimated the keff values by 0.5-1.1% Δk , and this problem has not resolved.
- In JENDL-4.0, the capture cross section of carbon at 0.0253eV, which is very important for HTGR criticality calculations, was revised the first time in 21 years.
- Replacing the nuclear data libraries with JENDL-4.0, the problem of overestimating the keff values is expected to be improved.

Introduction (2/2)

■ Objective

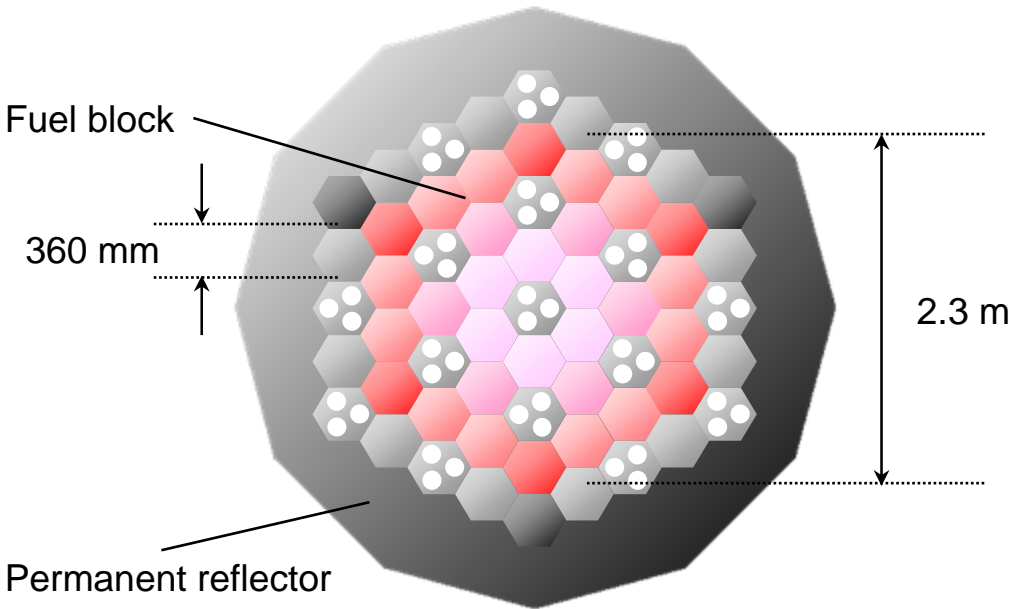
- Objective of this study is to investigate the applicability of JENDL-4.0 to the HTTR criticality.
- The investigation is performed by comparing the following two issues between the experimental results of the HTTR critical approach and the calculation results with JENDL-4.0, JENDL-3.3, ENDF/B-VII.0, and JEFF-3.1.
 - The loaded number of fuel column at achieving the first criticality.
 - Excess reactivity at the fully fuel columns loaded core.

Fuel configuration

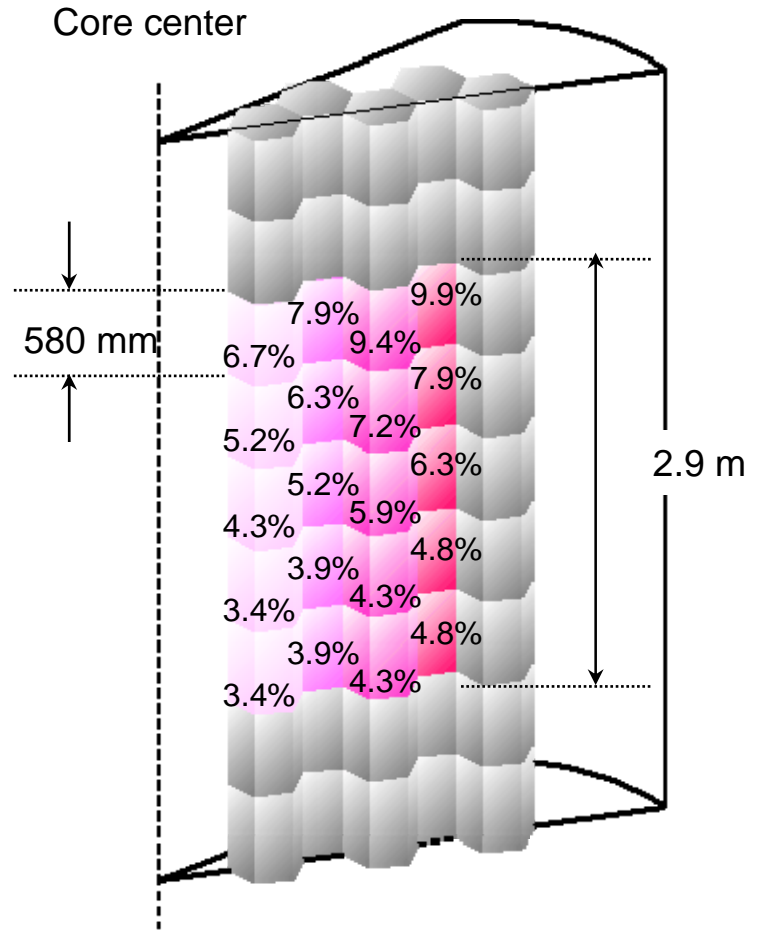


Core structure

Power	30 MWth
Coolant temp. of inlet / outlet	395 °C / 850 or 950 °C
Moderator / Coolant	Graphite / Helium gas
Core diameter / height	2.3 m / 2.9 m
Uranium enrichment	3 – 10% (Ave. 6%)



Horizontal cross-sectional view

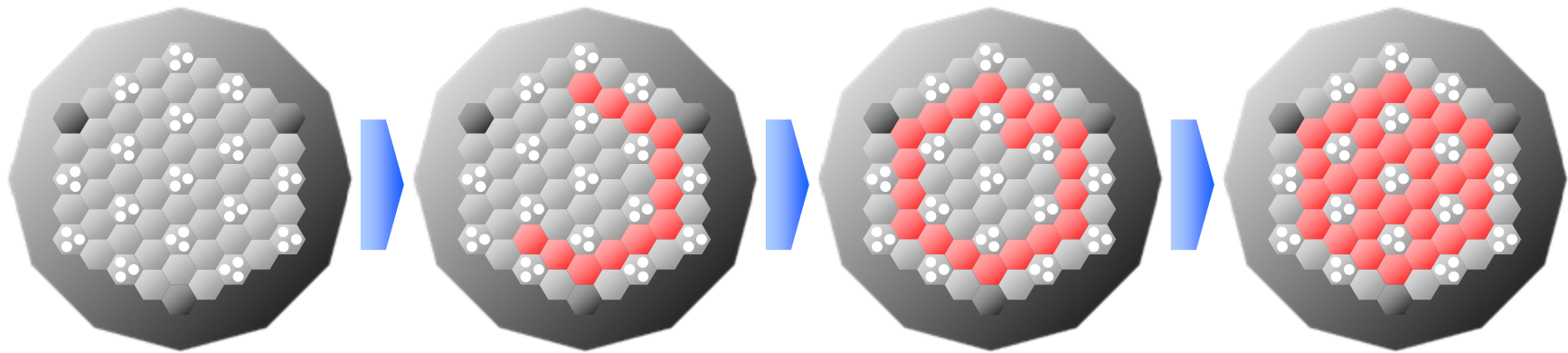


Bird's eye view

Critical approach

HTTR Critical Approach

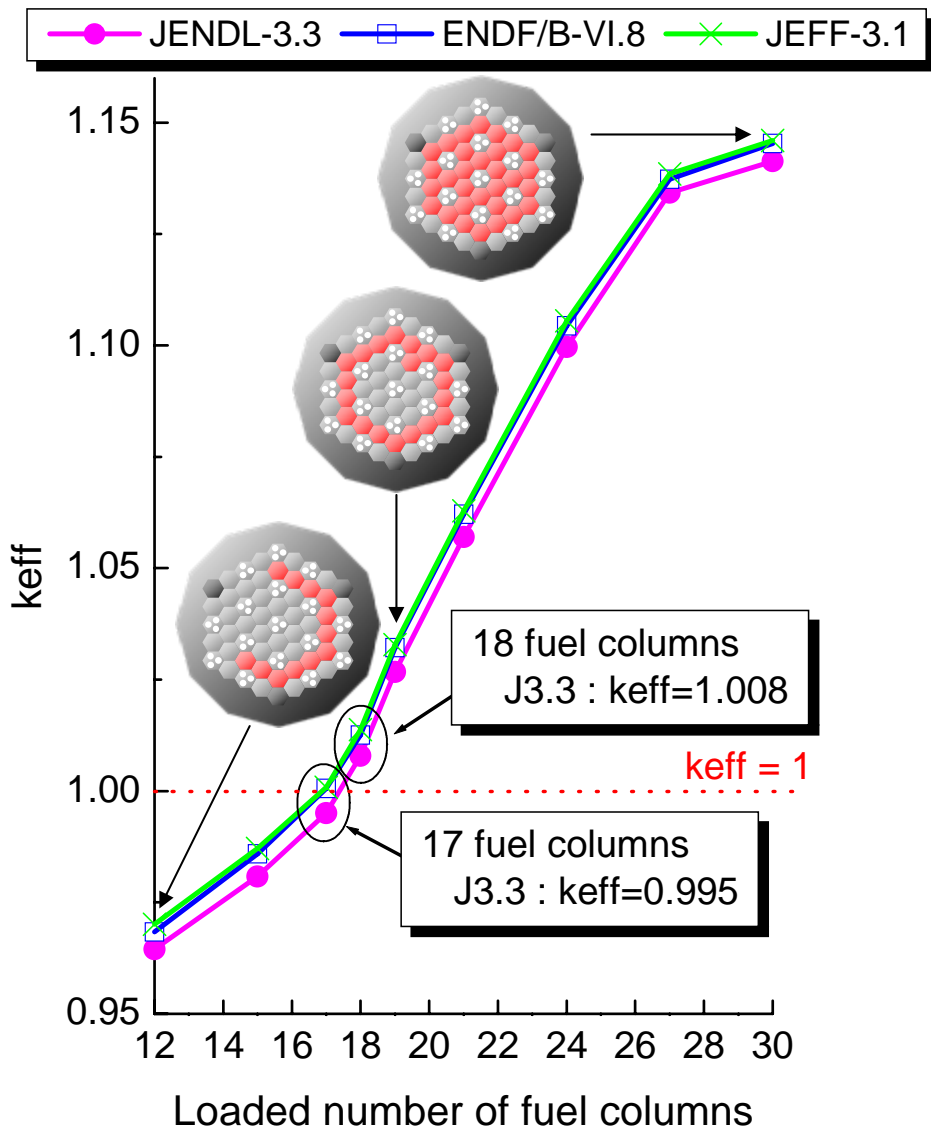
- Method : Fuel addition method (from outer region)
- Conditions : Room temperature and He atmosphere
- Results : First criticality was achieved by 19 fuel columns loaded



0 fuel column loaded core (Initial state) 12 fuel columns loaded core 19 fuel columns loaded core (First criticality) 30 fuel columns loaded core (Full core)

Graphite blocks regions were replaced with fresh fuel blocks from the outer core region

Results of previous study (1/2)



The loaded number of the fuel columns at achieving the first criticality

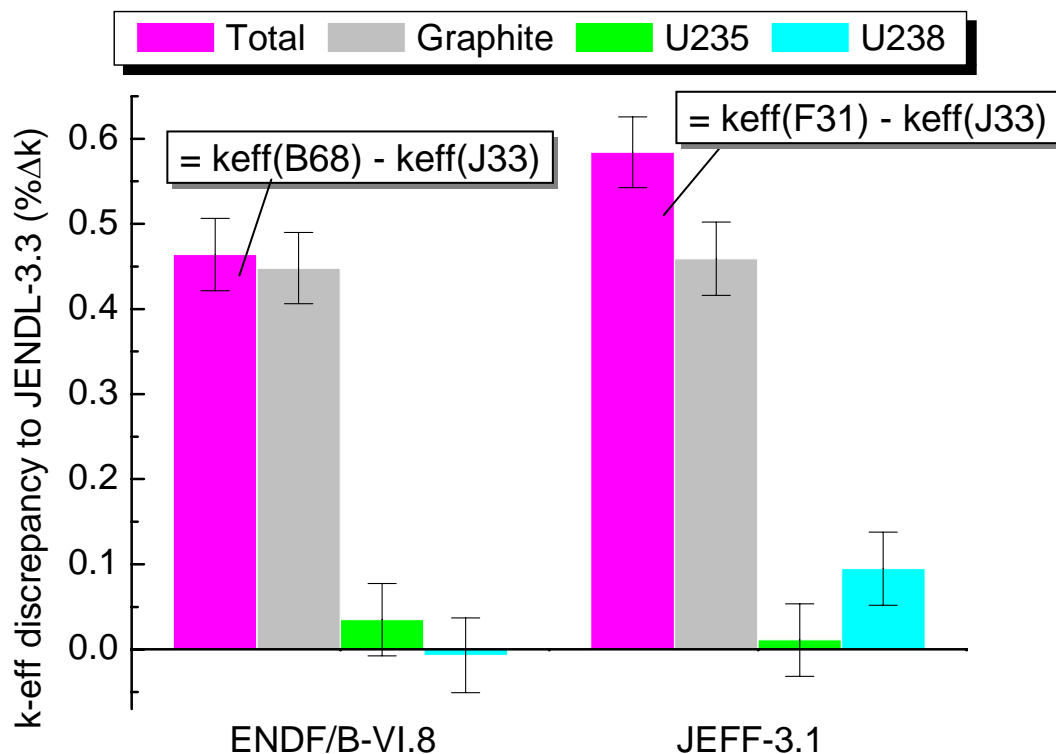
Exp.	J3.3	B6.8	F3.1
19	18	17	17

Excess reactivity at the fully loaded core ($\% \Delta k/k$)

Exp.	J3.3	B6.8	F3.1
12.0	12.5	12.8	12.8

JENDL-3.3 showed better applicability to the HTTR criticality calculations than ENDF/B-VI.8 or JEFF-3.1, but still overestimated the k_{eff} values.

Results of previous study (2/2)



Capture cross sections of carbon at 0.0253eV (mb)

JENDL-3.3	ENDF/B-VI.8	JEFF-3.1
3.53	3.36	3.36

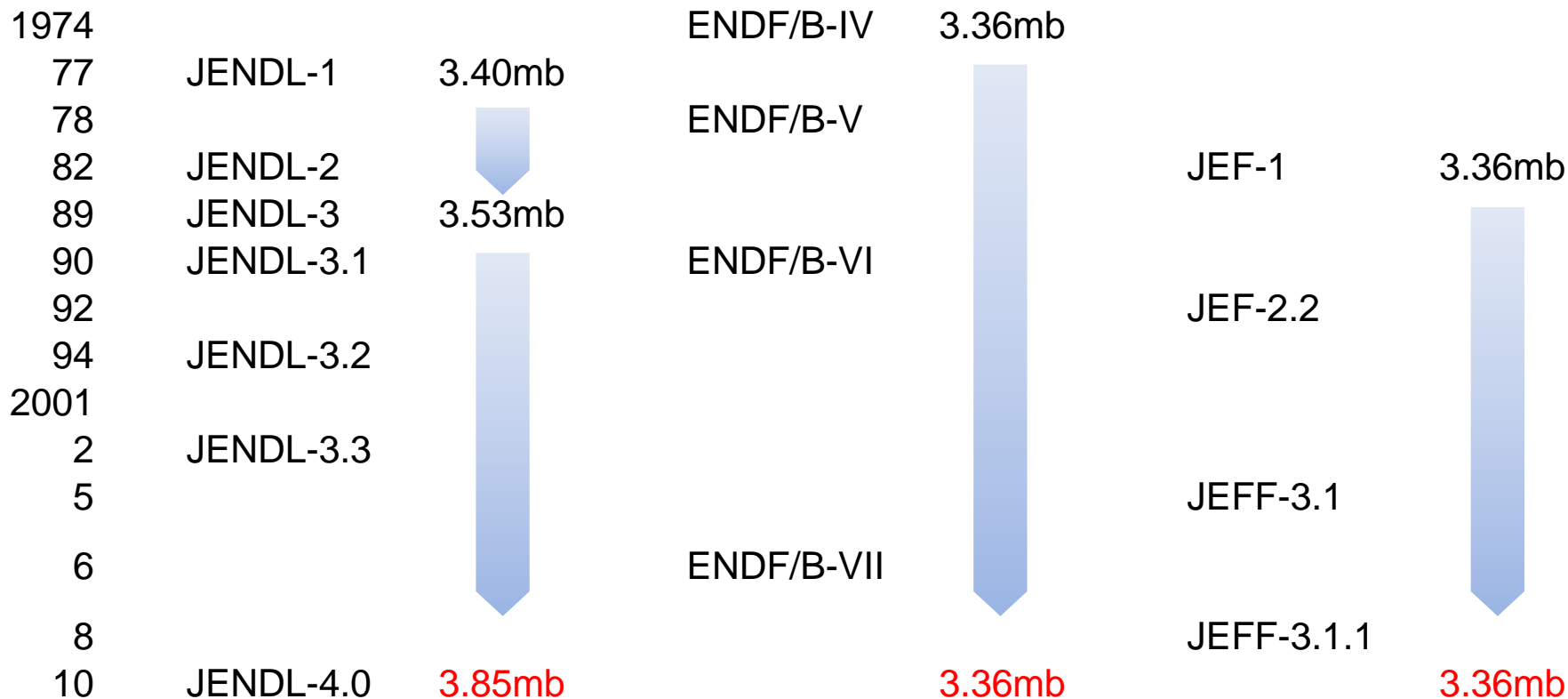
The capture cross section of carbon at 0.0235eV is very small, but that is very important in the criticality calculation of the HTTR.

Calculations with JENDL-4.0 (1/2)

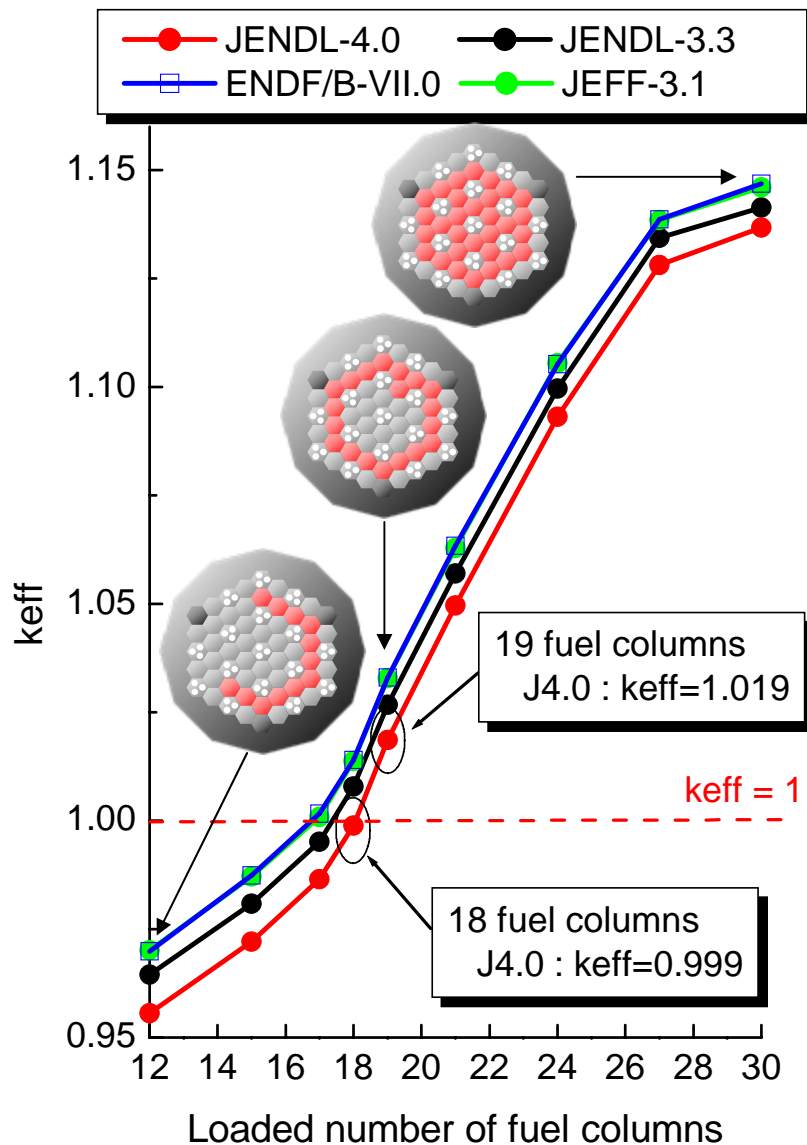
Japan

U.S.A.

Europe

Capt. Xsec.
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Calculations with JENDL-4.0 (2/2)



The loaded number of the fuel columns at achieving the first criticality

Exp.	J4.0	J3.3	B7.0	F3.1
19	19	18	17	17

Excess reactivity at the fully loaded core ($\% \Delta k/k$)

Exp.	J4.0	J3.3	B7.0	F3.1
12.0	12.0	12.4	12.8	12.7



Calculation results with JENDL-4.0 are agreed with the HTTR experimental data as expected, which fact shows the excellent applicability of JENDL-4.0 to the HTTR criticality calculations.

Summary

- Previous JENDL; JENDL-3.3, showed better applicability to the HTTR criticality calculations than ENDF/B-VII.0, VI.8 or JEFF-3.1, but still overestimated the keff values by 0.5-1.1% Δk , and this problem had not been resolved.
- In JENDL-4.0, the capture cross section of carbon at 0.0253eV, which is very important for HTGR criticality calculations, was revised the first time in 21 years, and the problem was expected to be resolved.
- Replacing the nuclear data libraries with JENDL-4.0, the problem of overestimating the keff values was resolved as expected, which fact shows the excellent applicability of JEDNL-4.0 to the HTTR criticality calculations.

Thank you for your attention