Validation of Ultra-Fine Group Library Generation of Lead-cooled Fast Reactor for STREAM code

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INTRODUCTION

STREAM (Steady state and Transient REactor Analysis code with Method of characteristics) is a high-accuracy neutron transport analysis code for light water reactors. However, STREAM has a problem to analyze non-light water reactors, sast reactor analysis, a new nuclear cross-section library for Fast reactors was tested for LFR pin and assembly problems in this literature. To enhance the accuracy of STREAM for fast reactor analysis, a new nuclear cross-section library for Fast reactors was tested for LFR pin and assembly problems in this literature.

Methods and Model Problem

- STREAM code does not use resonance treatment for fast reactor analysis.
- The STREAM XS library for the fast reactor case was constructed in accordance with ANL 1041 group structure and the ANL 2082 group structure used in the MC2-3 code, and the ECCO 1968 group structure used in the ERANOS 2.3 code.

Problem Setting for LFR Library

LFR Pin-cell problem Specification

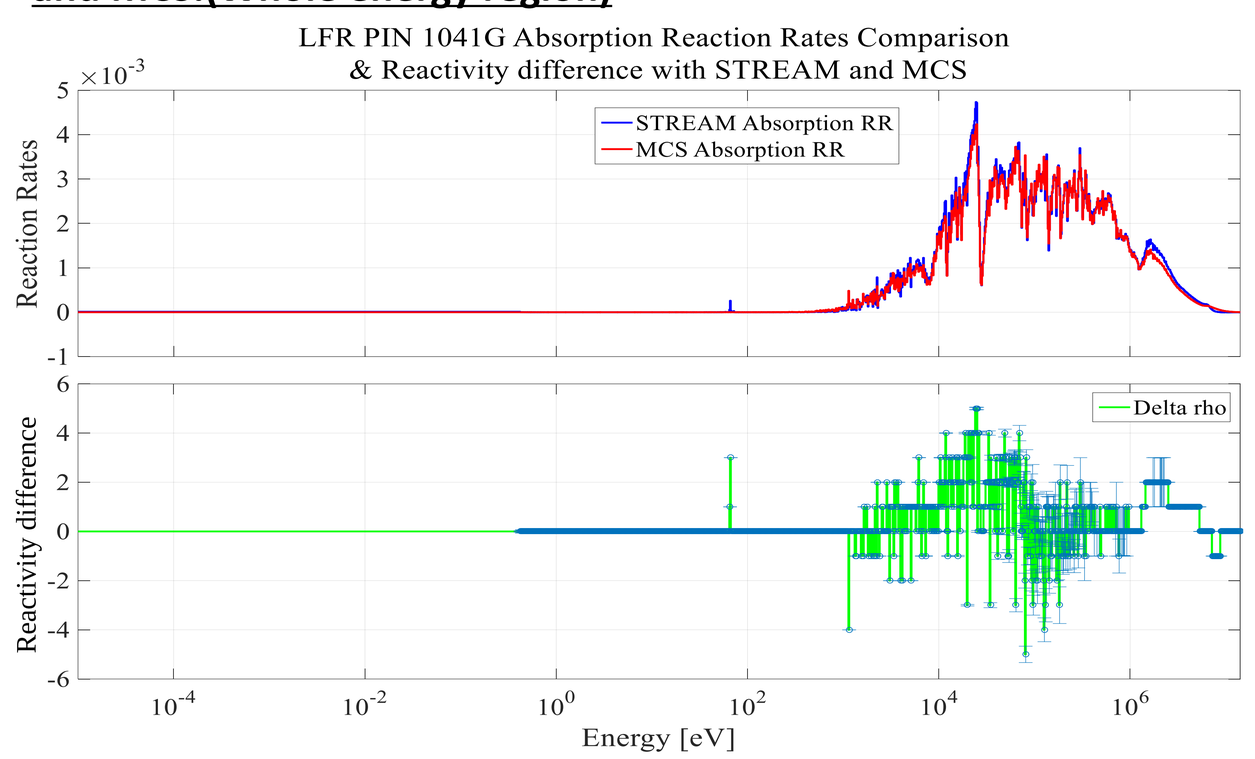
LFR Pin	Material	Radius[cm]	Nuclide
Pin	Fuel	0.32606	U,Np,Pu,Am,Cm,Zr (Inner : U-Pu 3.33 w/o) (Middle : U-Pu 6.35 w/o) (Outer : U-Pu 9.37 w/o)
	Pb	0.36384	Pb
	Zr	0.37399	Zr
	HT9	0.45000	Cr,Mn,Fe,Ni,Mo
	LBE	-	Pb,Bi

LFR Assembly problem Specification

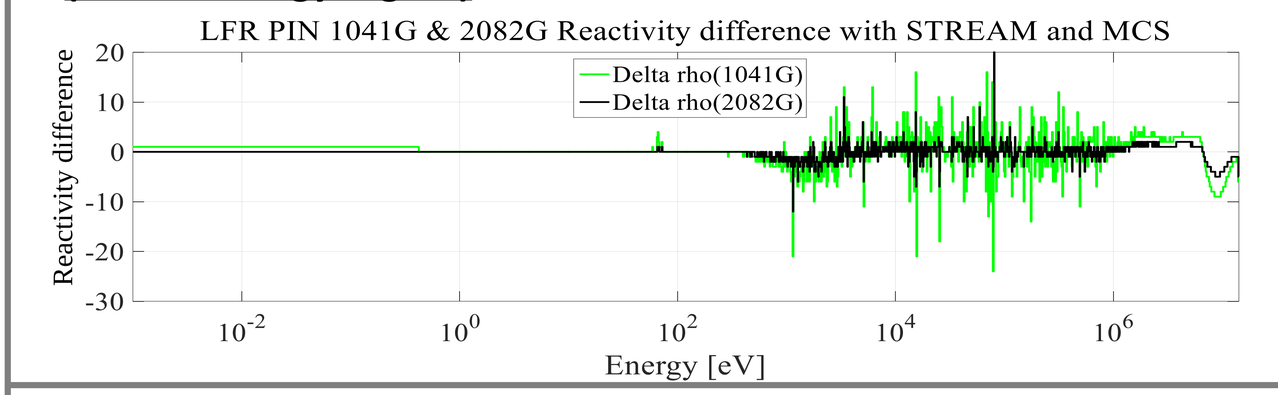
Assembly	Material	Radius[cm]	Nuclide
Fuel pin	Fuel	0.32606	U,Np,Pu,Am,Cm,Zr (U-Pu 6.35 w/o)
	Pb	0.36384	Pb
	Zr	0.37399	Zr
	HT9	0.45000	Cr,Mn,Fe,Ni,Mo
	LBE	-	Pb,Bi
Control rod	Pb	0.40500	Pb
	Zr	0.45500	Zr

RESULTS

Absorption Reaction Rates & Reactivity difference comparison of the middle pin-cell problem test results of STREAM(1041G Library) and MCS.(Whole energy region)



Reactivity difference comparison of the middle pin-cell problem test results of STREAM(1041G Library & 2082G Library) and MCS. (Whole energy region)



CONCLUSION

- This paper shows that the differences in the changes of the group structure are confirmed and the denser fine group structure has more accurate multiplication factor results.
- It would be necessary to apply an appropriate methodology and energy group for fast reactor analysis on STREAM code.

RESULTS

LFR Pin-cell problem calculation results comparison (STREAM 72, ANL 1041, ECCO 1968, ANL 2082)

LFR Pin	MCS		STREAM 72G(for LWR)		STREAM 1041G		STREAM 1968G		STREAM 2082G	
	k_{eff}	STD	k_{eff}	Diff. [pcm]	k_{eff}	Diff. [pcm]	k_{eff}	Diff. [pcm]	k_{eff}	Diff. [pcm]
Inner	0.95759	0.00004	0.99110	-3351	0.95559	-200	0.95695	-64	0.95672	-87
Middle	1.16190	0.00004	1.19004	-2814	1.15706	-484	1.15865	-325	1.15863	-327
Outer	1.33610	0.00004	1.35896	-2286	1.32934	-676	1.33103	-570	1.33099	-511

LFR Pin-cell problem average calculation times comparison (STREAM 72, ANL 1041, ECCO 1968, ANL 2082)

LFR Pin	MCS		STREAM 72G(for LWR)		STREAM 1041G		STREAM 1968G		STREAM 2082G	
	time[sec]	core	time[sec]	core	time[sec]	core	time[sec]	core	time[sec]	core
Time	598	133	11	1	552	1	2046	1	2034	1
Total time with 1 core	79534		11		552		2046		2034	

LFR assmebly problem calculation results comparison (STREAM 72, ANL 1041, ECCO 1968, ANL 2082)

LFR Assembly	MCS		STREAM 72G(for LWR)		STREAM 1041G		STREAM 1968G		STREAM 2082G	
	k_{eff}	STD	k_{eff}	Diff. [pcm]	k_{eff}	Diff. [pcm]	k_{eff}	Diff. [pcm]	k_{eff}	Diff. [pcm]
Assembly	1.14870	0.00004	1.17813	-2943	1.14412	-458	1.14560	-310	1.14565	-305