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Preliminary Verification Calculation of DeCART/CAPP System by HTTR Core Analysis

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1. Introduction

The two step core analysis system HELIOS/CAPP [1] or DeCART/CAPP [1] has been developed for VHTR core analysis by KAERI. In the system, first the HELIOS [2] or DeCART [3] code is used for homogenized cross-section generation, and second the CAPP is used to calculate the core physics parameters. In this study, the DeCART/CAPP system verification calculations have been performed against the Japan's HTTR (High Temperature Engineering Test Reactor) [4,5] configurations. The calculations are carried out for single cell and single block models. The reference calculations are performed by the McCARD code [6].

2. DeCART/CAPP code system

Fig.1 shows the DeCART/CAPP code system for VHTR. In the system, the DeCART code performs lattice calculation for a spectral geometry to generate homogenized few-group cross sections. Then the PXS_GEN [1] converts the cross sections to the format of the CAPP. Finally, the CAPP performs core calculations with provided cross-section set.

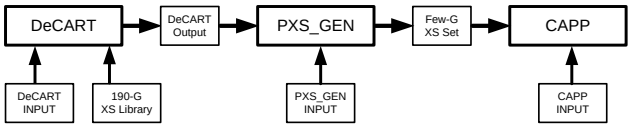

Fig.1 DeCART/CAPP Code System

3. Results and Discussion

The HTTR is a graphite-moderated and helium gas cooled reactor with a 30 MWth power. The reactor operational mode at 850°C is defined as "rated operation" and 950°C is "high temperature test operation".

3.1 Single cell model

There are 12 different fuel types in HTTR fuel. In this study, the fuel is modeled for 5.2wt% fuel as shown in Fig. 2. Hexagonal pitch is 5.15 cm and radii of center hole and compact are 0.5 and 1.3 cm, respectively. Table I shows the temperature variation results for single cell. As shown in Table I, DeCART overestimates k_{inf} value for all temperature range. Also, the DeCART/CAPP system gives very small differences from the DeCART results.

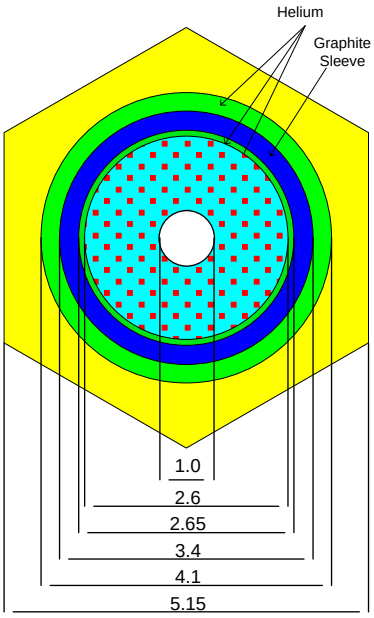

Fig. 2 Single Cell Model

Table I Temperature Variation Results for Single Cell

T_m [K]	T_f [K]	McCARD	DeCART	DeCART/CAPP	
		K_{inf} (M)	$\Delta\rho$ (D-M) [pcm]	$\Delta\rho$ (C-M) [pcm]	$\Delta\rho$ (C-D) [pcm]
700	700	1.26894	195.8	182.2	-13.6
700	800	1.25864	165.0	157.5	-7.5
700	900	1.24859	167.1	164.5	-2.6
800	800	1.25639	201.6	189.5	-12.0
800	900	1.24649	196.5	187.5	-9.0
800	1000	1.23754	170.7	164.2	-6.5
1000	1000	1.23489	162.3	163.0	0.7
1000	1100	1.22682	116.1	114.8	-1.3
1000	1200	1.21832	127.1	125.8	-1.3
1200	1200	1.21526	187.8	184.4	-3.4
1200	1300	1.20734	188.9	182.8	-6.1
1200	1400	1.20031	152.4	143.4	-9.0
1200	1500	1.19320	142.3	131.8	-10.5

3.2 Single block model

Fig. 3 shows the HTTR fuel block model with 33 fuel pins. There are also 1 central fuel handling hole and 3 burnable poison (BP) holes.

Table II represents the temperature variation of single block model with BP. From the results, DeCART underestimates the k_{inf} values from ~260 to ~330 pcm. CAPP underestimates the k_{inf} values lower moderator temperature than 1200°C. But slight overestimations are observed at higher moderator temperature than 1200°C. CAPP gives very small differences in k_{inf} values when compared with those of the DeCART results.

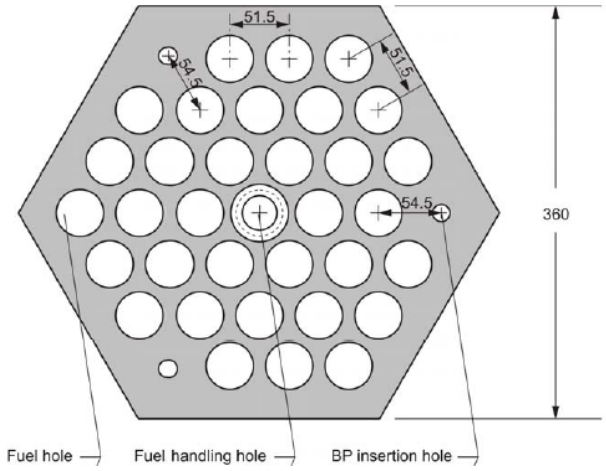

Fig. 2 Single Block Model

Table II Temperature Variation Results for Single Block

T_m [K]	T_f [K]	McCARD	DeCART	DeCART/CAPP	
		K_{inf} (M)	$\Delta\rho$ (D-M) [pcm]	$\Delta\rho$ (C-M) [pcm]	$\Delta\rho$ (C-D) [pcm]
700	700	1.17935	-303.0	-309.6	-6.5
700	800	1.17365	-332.3	-335.3	-2.9
700	900	1.16742	-292.3	-293.0	-0.7
800	800	1.16664	-277.2	-289.7	-12.6
800	900	1.16117	-289.5	-300.7	-11.2
800	1000	1.15595	-294.4	-305.7	-11.3
1000	1000	1.14462	-262.6	-261.8	0.8
1000	1100	1.14011	-294.1	-295.6	-1.5
1000	1200	1.13541	-295.8	-295.8	0.0
1200	1200	1.12545	-258.1	-253.4	4.8
1200	1300	1.12112	-267.3	-264.1	3.2
1200	1400	1.11686	-267.8	-265.3	2.4
1200	1500	1.11292	-280.2	-278.6	1.6

4. Summary

The DeCART/CAPP verification calculations have been performed with the HTTR core configurations. From the single cell results, it is known that DeCART overestimates k_{inf} value for all temperature range, and that the DeCART/CAPP system gives very small differences from the DeCART results. For the single block, the DeCART underestimates the k_{inf} at lower moderator temperature but overestimates at higher moderator temperature. When CAPP is compared with DeCART, CAPP overestimates the k_{inf} values.

In future, temperature coefficients will be compared and depletion calculation will be performed. Also, 2- and 3-dimensional core calculations will be performed.

REFERENCES

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