Preliminary Core Analysis of High Temperature Engineering Test Reactor Using DeCART Code

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1. Introduction

The 2-dimensional core analysis for the High Temperature Engineering Test Reactor (HTTR) has been performed. The HTTR is a graphite-moderated and helium gas cooled reactor with an outlet temperature of 950℃ and thermal output of 30 MW [1].

In this study, the DECART code [2] is used with a 190-group KARMA library. The calculation results are compared with those of the McCARD [3] with the ENDF-B/VII.0 library.

2. HTTR Core Model

Table 1 shows and the HTTR core specifications and Fig.1 shows the 1/3 core model. The HTTR core is an annular type form. The reactor core component is arranged in the reactor pressure vessel, which has a 13.2 m height and 5.5 m diameter. The core consists of 30 fuel columns and 7 control rod guide columns with an active core height of 290 cm and a 230 cm effective diameter. An additional 9 control rod columns are located in the outer reflector region. The replaceable reflector region adjacent to the active core consists of 9 control rod columns, 12 replaceable reflector columns, and 3 irradiation columns. There are 2 top reflector blocks, 5 fuel blocks, and 2 bottom reflector blocks in each fuel column.

Table I: Specification of the HTTR

Parameter	Value
Thermal power	30 MW
Outlet coolant temperature	950℃
Inlet coolant temperature	395℃
Equivalent core diameter	230 cm
Effective core height	290 cm
Uranium enrichment	3 to 10 wt%
Fuel type	Pin-in-block
Number of fuel blocks	150
Number of fuel columns	30
Number of control rod block	
In core	7
In reflector	9

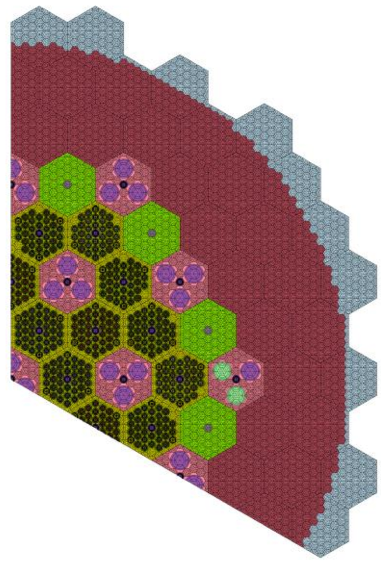

Fig.1. HTTR 1/3 symmetry core model

3. Results and Discussion

Previous study [4] has shown that the results of unit cell and single block are agree well with those of the McCARD code.

Fig.1 shows a 2-D 1/3core model of HTTR. Table II shows the temperature variation results for the HTTR 2-D core model with different reflector temperature Tr. A relatively large k_{inf} error was observed at a high moderator temperature. In addition, the reflector temperature effect was not much in total reactivity variation.

From the temperature coefficient analysis results, as shown in Fig. 2 and 3, it is known that the DeCART code overestimates the moderator temperature coefficient (MTC). But DeCART code underestimates slightly the fuel temperature coefficient (FTC) when compared to those of the McCARD.

As shown in Fig. 4, the depletion results gives a maximum reactivity error with BP is about 187 pcm in the beginning of the depletion. The error decreases until ~600 FPD, and it starts increase slightly. The trend between McCARD and DeCART is very similar to each other.

Table II: Temperature variation results for 2-D core

T_m [K]	T_f [K]	$\Delta\rho$ [pcm]		
		Tr=700*	Tr=1000	Tr=1200
700	700	109.0	-	
700	900	96.6	-	
800	900	134.1	-	
1000	1000	151.4	145.4	
1000	1200	144.0	131.8	
1200	1200	180.7	121.7	178.8
1200	1300	163.7	176.0	176.9
1200	1500	156.7	138.0	146.7

* in K

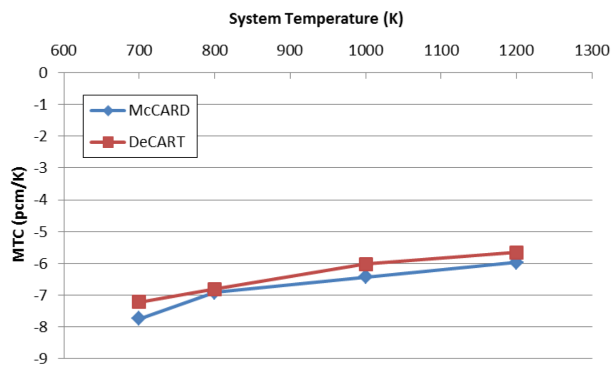

Fig.2. MTC of 2-D core

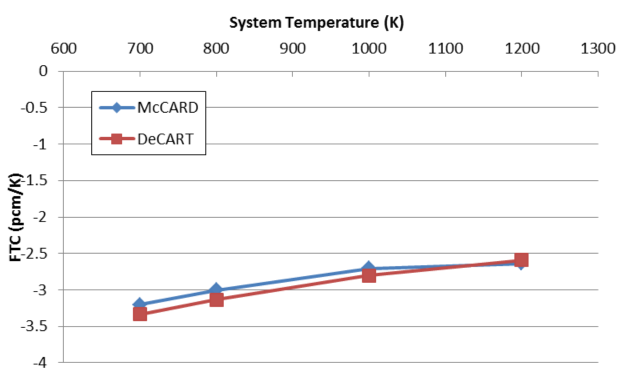

Fig.3. FTC of 2-D core

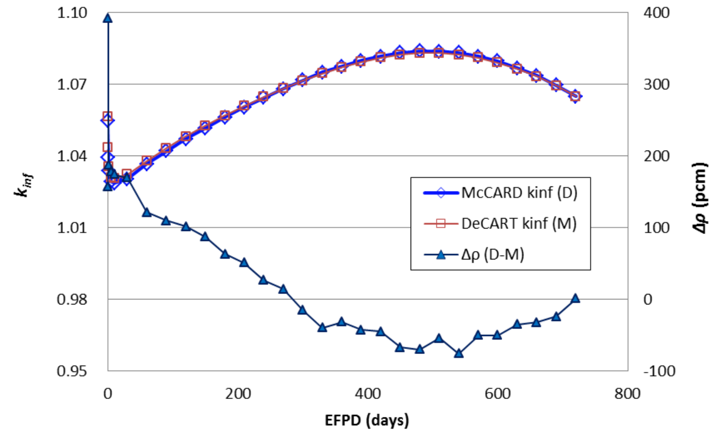

Fig. 4. 2-D core depletion results

4. Summary

From the analysis results, it is known that the DeCART code generally overestimates k_{inf} with a moderator temperature variation. In addition, it can be seen that the DeCART code predicts less negative MTC than the McCARD code. However, the DeCART code gives a slightly more negative FTC value. From the depletion results, the error of the DeCART decreases over the burnup until 600 FPD. The DeCART code gives very similar trend within the error of 190 pcm, which is very small error when compared with other result [5].

REFERENCES

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