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Subcriticality Measurement of AGN-201K Reactor Using the Modified Neutron Source Multiplication Method

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1. Introduction

In this study, Modified Neutron Source Multiplication method (MNSM) was verified by the various experiments in AGN-201K reactor, Kyung Hee University. This method was tested by computational simulation at Kyung Hee University in 2006. In order to calculate correction factors, reactor analysis code system should be set up for the calculation of neutron fluxes and adjoint fluxes. In 2006, PARTISN code and multi-group cross-section library, ZZ-KASHIL199N was established and validated by the comparison with MCNP. In this study, calculation module for correction factors was invented by using the FORTRAN77 language to handle massive data of flux output from PARTISN code. In addition, the investigation the correction factor effectiveness, various reactor conditions were tested by six kinds of experiments.

2. PARTISN code modeling

PARTISN code is SN code which can calculate the three-dimensional geometry and solve the eigen value problem and the fixed source problem.

Table 1 shows the number of nodes that used for PARTISN code calculation. And Figure 1 shows PARTISN code model of AGN-201K.

Table. 1 Number of node for PARTISN code

Type of flux	Three dimension			Energy
	R	Z	Θ	
Forward flux	31	66	10	199
Adjoint flux				
Fixed source flux				

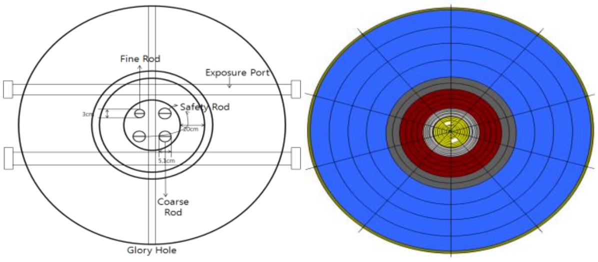


Fig. 1 PARTISN code Model of AGN-201K

3. Calculation of correction factor

3-1. NSM and Modified NSM

There are several methods for measurement of subcriticality. Neutron source multiplication method(NSM) is such as one kind of such methods. But this method does not consider reactivity change. Therefore, it needs some corrections. The NSM method is defined as follows:

$$\rho_n = \rho_{ref}\left(\frac{M_{ref}}{M_n}\right) \tag{1}$$

Where, M_{ref} and M_n are defined as count rate of each reference subcritical state and n-th subcritical state.

In other to correct the NSM, the Modified Neutron Source Multiplicaion(MNSM) method was proposed by Hokkaido university in Japan.

The MNSM method is defined as follows:

$$\rho_n = \rho_{ref}\left(\frac{M_{ref}}{M_n}\right)C_n^{ext}C_n^{sp}C_n^{im} \tag{2}$$

Where, C_n^{ext}, C_n^{sp} and C_n^{imp} are defined correcti on factors which extract fundamental mode, spatial distribution and neutron importance field perturbation due to change of reactivity.

3-2. Correction factors

For the calculation of correction factors in MNSM method, three fluxes in each nodes respectively state should be calculated as matrix. In order to calculate the correction factor, the calculation module was invented to handle massive data by using the FORTRAN77 language.

4. Measurement subcriticality of AGN-201K

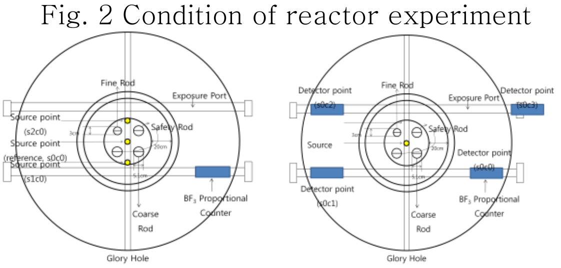
4-1. AGN-201K reactor experiment

In order to test the correction factor effectiveness, various reactor conditions were tested by six kinds of experiments. Figure 2 shows condition of reactor experiment and table 2 shows that reactor experiments are classified based on source and detector position.

Table. 2 Case of reactor experiment

CASE	Reactor experiment	
s0c0	Reference	Source : Core center Detector : Reflector
s1c0	Source point changes	Core boundary
s2c0		Core boundary
s0c1	Detector point changes	Detector : Reflector
s0c2		Detector : Reflector
s0c3		Detector : Out of reactor

Fig. 2 Condition of reactor experiment



4-2. Measurement subcriticality by using NSM and MNSM method

In this study, MNSM method was estimated through AGN-201K reactor experiments. To know the effect of correction, it were compared NSM and MNSM method as integral reactivity of respectively subcritical state.

Figure 3 show the result compare NSM and MNSM method as different detector position. And figure 4 show the result comparison of NSM and MNSM method as different source position.

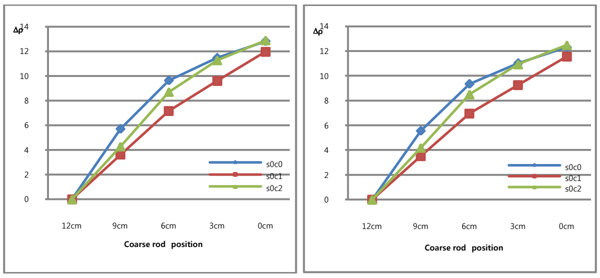


Fig. 3 comparison integral reactivity in different detector position(the left picture is NSM and the right is MNSM method)

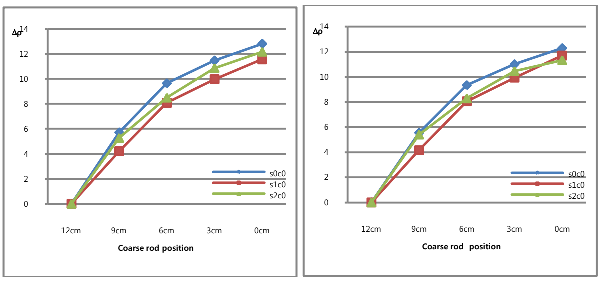


Fig. 4 comparison integral reactivity in different source position(the left picture is NSM and the right is MNSM method)

From figure 3, it was found that there is no correction effect following the detector position. From figure 4, however it has correction effect following the source position. Though the detector position was different, the distance from source to detector was same in figure 4. But the distant from source to detector was different following change of source position. From these results, it seems that correction effect is related distance of source and detector.

5. Conclusion

In this study, MNSM method was verified by the various experiments in AGN-201K reactor, Kyung Hee University. For complicated calculation of correction factors, it needs the calculation module to handle massive data. In this study, Calculation module was invented by using FORTRAN77 language. The results shows correction effect has only due to the source position change. It may be concluded that correction effect is related distance of source and detector from these results.

6. Reference

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