Development of RFSP – NUCIRC Interaction Module

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1. Introduction

For heavy water reactor core analysis and thermal hydraulic analysis, RFSP code [1] and the NUCIRC code [2] should be used consecutively. In this case the result of computation of one program is used for input data and information of the other program. For example, it is determining the channel flow distribution of 100% power from the NUCIRC code by using time-averaged bundle power distribution data of 100% power calculated from the RFSP code. However, a result of coming out of the RFSP code don't give converged input data about bundle power. Because of that, it calculates many times and it has to deliver with NUCIRC input. The troublesome process calculated by the PYTHON program [3]. PYTHON is the script language. The connected python module of the RFSP code and NUCIRC code were developed in order to overcome this disadvantage. The Modeling is CANDU 6 reactor.
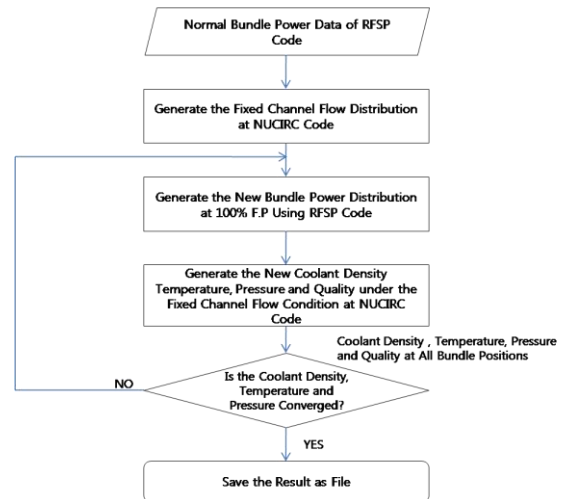
2. Methodology of PYTHON Module

As shown in Figure 1, interaction of RFSP and NUCIRC was calculated with existing method, it is complicated. So as shown in Figure 2, this complicated process was automated.

The bundle power calculated in RFSP is given in the NUCIRC input. Then, the density of a coolant, temperature, pressure, and quality value comes out and this is ITERATION 1. In iteration 2, TAPE2 (Bundle-centered Coolant Density, Temperature and Pressure Profile), that is the result of the NUCIRC code coming out of iteration 1, is given as the input of the RFSP code and then bundle power is outputted. This bundle power is passed over on NUCIRC input data and the density of the coolant, temperature, pressure and value of the quality, that is the results of NUCIRC at iteration 2, are outputted.

In the same way, it calculates iteration 3, 4 and 5 repetitively. And when finding the coolant density, a temperature and pressure value about each location of channels and comparing in the last step of iteration with that, the largest difference value is found. It programed so that it could be converged when the value was 10^{-4} or less.
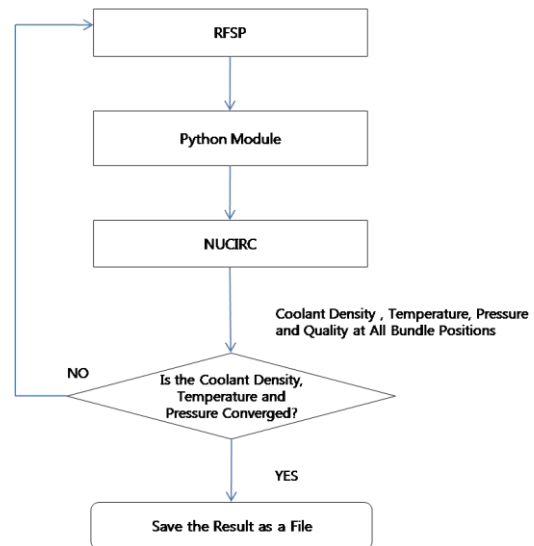

Fig. 1 Passive Calculation

Fig. 2 Automatical Calculation

3. Evaluation of Python Module

By using the python module, k-effective value about power was produced and it evaluated. The result of

producing a k-effective through the passive calculation and the k-effective result of calculating the automatic by using the python module are same. Therefore, it is seen that the python module performs the exact calculation. The calculation time is shortened. In this module, the convergence was evaluated in the other condition. Comparing the k-effective value of the current cycle with the k-effective value of the next cycle, the convergence condition 1 calculates the critical value if it is same. The convergence condition 2 calculates that criticality is converged when comparing the coolant density, temperature and pressure of the current cycle to the values of the next cycle if its difference is 10^{-4} or less. As shown in figure 3, when attempting to compare two conditions, there is the difference of the k-eff value at 70% output but the result of the convergence condition 1 and 2 is the same at the other condition.

Table 1. K-eff about Convergence condition

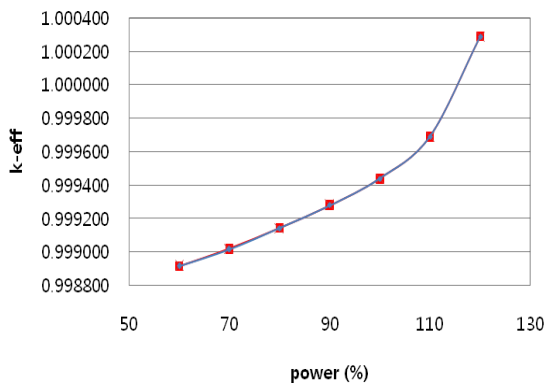| Power(%)	Condition 1(k-eff)	Condition 2 (k-eff)
60	0.998917	0.998917
70	0.999018	0.999020
80	0.999145	0.999145
90	0.999282	0.999282
100	0.999440	0.999440
110	0.999691	0.999691
120	1.000290	1.000290

Fig. 3 k-eff about power

4. Conclusion

Connect method of RFSP and NUCIRC code was very complicated on an existing. Therefore, the module which connects automatically this complicated procedure by using python script language was developed. This linking

module reduces the oversight coming due to the passive calculation and shortens the calculation time.

By using this linking module and applying the convergence condition 1 and 2, the criticality value was attempted to compare. The difference of a value is small and convergence condition 1 and 2 able to use altogether and they can obtain the result of being satisfied.

REFERENCES

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[3] K. S. Lee, "PYTHON," 2003