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Analysis for Measured Data from Secondary Coolant Radiation Monitor of HANARO

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1. Introduction

In research reactors as well as nuclear power plants, any release of radionuclide from the primary coolant into the secondary coolant should be detected as soon as possible. In HANARO, 30 MW research reactor, the secondary coolant radiation monitor have measured the radiation from secondary coolant using the gamma-ray detection system. An NaI(Tl) detector is placed under the secondary cooling circuit in order to monitor the gamma-ray activity in the coolant.

In this research, we have analyzed the data measured from the secondary coolant radiation monitor.

2. Analysis for radionuclide in coolant water

Figure 1 shows the whole trend of the measured count rate of secondary coolant radiation monitor. As shown in the figure, when the reactor is operating with the nominal power, the measured count rates become slightly larger than those in the state of reactor shutdown. The averaged value of the data in the power operation is 156.1 cpm, while that in the shutdown period is 137.4 cpm.

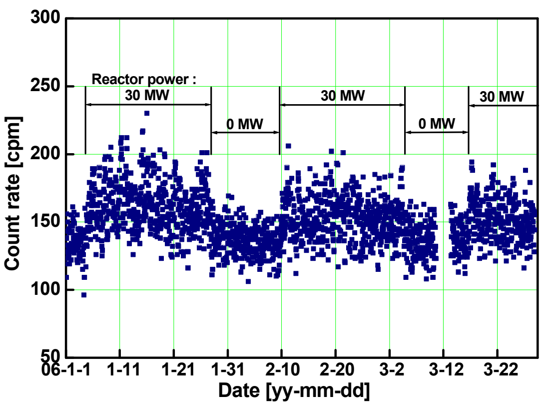

Figure 1. Whole trend of the measured count rate of secondary coolant radiation monitor.

In order to investigate the cause of the activity increase, we analyzed the radionuclide in the secondary coolant water of 500 cc and the sludge of the coolant basin of 125 cc by gamma-ray spectroscopy with HPGe detector.

Table 1 shows the results of the radionuclide analysis. As shown in the table, any radioisotope transferred from the primary coolant or activated by the reactor neutron was not detected. It is confirmed that the activity concentrations of the natural background radionuclide in the basin sludge are rather high. Since about 50 tons of water is evaporated in an hour from the cooling tower, a large amount of background nuclide was sedimented into the coolant basin. Therefore, it can be assumed that the activity increase during the reactor operation is caused by the flow of the natural background nuclide with the circulated coolant water.

Table 1. Equivalent gamma-ray peak area in the radionuclide measurements for the secondary coolant water and the sludge of the coolant basin.

Peak energy [keV]	Nuclide	Basin sludge	Coolant water	Background
46.5	Pb-210	525	22	6.0
63.3	Th-234	34	119	105.7
92.5	Th-234	144	0	0
186.2	Ra-226	249	90	115.7
238.6	Pb-212	612	112	38.7
241.0	Pb-214 /Ra-224	46	26	41.0
295.2	Pb-214	145	94	66.7
338.3	Ac-228	131	0	0
351.9	Pb-214	162	111	116.0
583.1	Tl-208	173	0	0
609.3	Bi-214	182	79	97.7
661.7	Cs-137	43	0	0
727.2	Bi-212	52	0	0
911.1	Ac-228	173	23	20.3
969.1	Ac-228	78	0	0
1120.3	Bi-214	34	12	10.7
1173.2	Co-60	13	3	7.7
1332.5	Co-60	9	14	12.3
1460.8	K-40	278	171	155.7
1764.5	Bi-214	48	20	33.0
2614.7	Tl-208	132	63	68.3
Sum of spectrum count		47925	35748	35404.0

The sum of the gamma-ray spectrum of the coolant water is slightly bigger than that of the background counting by about 1%, which is small, considering the uncertainty of the counting. However, the total amount of coolant water viewed by the detector of the radiation monitor during the circulation of secondary coolant is much larger than that in this measurement using HPGe detector. And also, the continuous supply of the short–lived background radionuclide such as Pb-214, Tl-208 and Bi-212 is possible by the circulation of the coolant.

2. Detailed trend of measured data

Figure 2 shows the detailed trend of the count rate of the secondary coolant monitor. From the figure, we can see the oscillation of the count rate with a constant frequency.

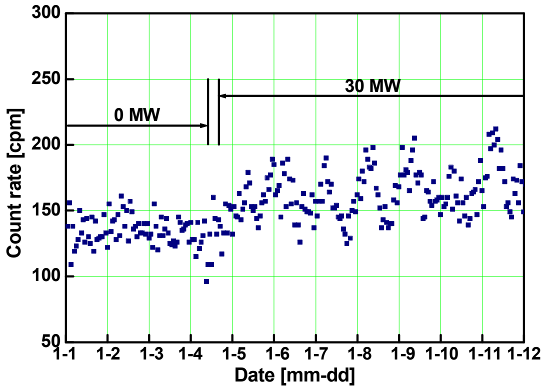

Figure 2. Detailed trend of measured count rate of the secondary coolant monitor.

From the FFT analysis, it is confirmed that the frequency is about 1 day. This oscillation cannot be seen in the reactor shutdown period.

Figure 3 shows the trend of measured count rate and the variations of the ambient temperature and relative humidity offered by the Daejeon Regional Meteorological Office.

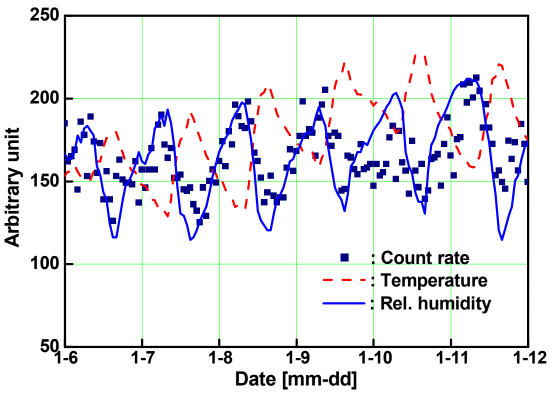

Figure 3. Trend of measured count rate and the variations of the ambient temperature and relative humidity.

From the figure, we can see that the measured count rate is correlated with the ambient circumstance. Till now, we have assumed that the variation of the count rate was originated from the change of the radon content in the coolant water. Radon is the representative gaseous natural background source, and the change of radon content in the water is dependent on the ambient condition[1,2].

Conclusively, so far, we can see that the increase of the count rate of secondary coolant radiation monitor during the reactor operation is caused by the flow of the natural background nuclide with circulated coolant water, and that the variation of the count rate is dependent on the radon content in the coolant water.

REFERENCES

[1] F. Marley, A.R. Denman and P.S. Phillips, Examination of the influence of water-heated central heating systems on the levels of radon and radon progeny in the workplace, Radiation Measurements, 32, pp.15-25, 2000.

[2] Z. Kasztovszky, L. Sajó-Bohus and B. Fazekas, Parametric changes of radon (^{222}Rn) concentration in ground water in Northeastern Hungary, J. Envirn. Radioact., 49, pp.171-180, 2000.