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Improvement of Data Processing of the Tritium Monitor installed at the HANARO Stack

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1. Introduction

Tritium, particle, iodine and noble gas detectors have been installed at the HANARO stack, and they are continuously being operated to monitor the abnormal emissions of the above radioactivities. The tritium concentration in the air from the reactor hall is the lower level than the reliably detectable activity concentrations by the monitor. Thus the measured tritium concentration has easily been affected by the detector backgrounds and the activity of ambient noble gas. Since it is impossible to increase the sensitivity of the monitor so far, we decided to improve the processing of the output data from the monitor. First of all, we analyzed all data from the monitor. And, we concluded that an improvement would be possible by using the data from the RMS (Regional Monitoring System) noble gas monitor. Thus, in this paper, the methodology for producing the reliable data from the stack tritium monitor is described.

2. Present status of the monitor

Two tritium monitors were installed at the stack of HANARO to measure the tritium concentrations in the evacuated air from the reactor hall and RCI (reactor concrete island) region. The monitor is a methane gas flow proportional counter, and it can be used as noble gas monitor. The characteristics of the monitor are represented in Table 1. The tritium counter tube is made of three flow tubes with the detection counter tube in the middle being separated from the two shielding counter tubes by a special grid. The methane-sample air mixture passes through the tritium flow counter tube. While the pulses due to tritium only occur in one of the three counter tubes, the ambient radiation causes coincident counts in all three counter tubes. This background signal is eliminated by anticoincident coupling of the three counter tubes. The concentrations of the tritium and noble gas activities are described by

$$T = C_T[(ACO - ACO_0) - Z(CO - CO_0)], \quad (1)$$

$$NGA = C_{NGA}(CO - CO_0), \quad (2)$$

where,
C_T, C_{NGA}: tritium and noble gas calibration factors,
ACO, CO: anticoincident and coincident count rates,
ACO_0, CO_0: backgrounds of anticoincident and coincident counting channel,
Z: compensation factor for the tritium measurement.

Fig. 1 shows the variations of activity concentrations of the tritium and radioactive noble gas for three months last year. The noble gas concentration has been measured by RE019 RMS monitor. The calculation data by using the ACO and CO count rates and Eq. (1) shows a large statistical deviation, and its mean value over a cycle time is much lower than the measured value by using the bubbling method. Bubbling is regarded as the most reliable method, but it cannot be applicable in real time. Moreover, the tritium concentration decreased abruptly when the concentration of the noble gas was increased in the mid-November. This is basically because the measurements are near the lower limit of the reliable range of the monitor.

Table 1. Characteristics of the HANARO tritium monitor.

Parameters	Features
Detector type	Open CH_4 gas flow proportional counter
Model	FHT 63 D, ESM Eberline
Set flow rates	Methane: 24.5 l/h, sample air: 11.8 l/h
Shielding	4π lead, thickness: 50 mm
Measuring range for pure tritium	10^3 - 10^8 Bq/m^3
Air, methane ratio	1:2.08
Gas volume	3 liters
Background signal	Anticoincidence channel < 1 s^{-1} Coincidence channel < 15 s^{-1}
Calibration factors	H-3 4462 Bq· m^{-3}·sec Kr-85 2420 Bq· m^{-3}·sec
Compensation factors for tritium	Kr-85 0.46

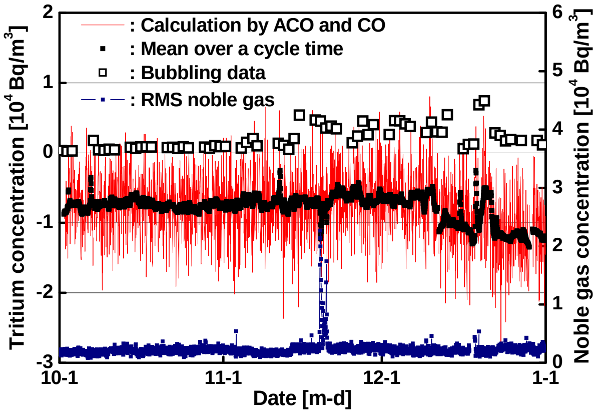

Fig. 1. Variations of activity concentrations of tritium and radioactive noble gas for three months in 2008.

3. Methods

Background values of the ACO and CO channels have been measured periodically. However, it is very hard to make the background condition on which there are no tritium and noble gas contributions in the reactor field. Therefore, it can be considered that the measured backgrounds are not reliable. Also, since the CO count rate is affected by the noble gas activity in the reactor hall, tritium concentration can be decreased according to the increase of the noble gas concentration. Thus, we changed the background evaluation method.

Fig. 2 shows the concentrations of the noble gas activities from the tritium and RMS monitors. It is confirmed that the two data are correlated with each other. Among the noble gas activities, Kr-85 is in charge of the basis level, and the peak is caused by Ar-41. Since the sensitivity of the RE019 RMS monitor for Ar-41 was well established [1], we deduced the new background by using RMS data as follows.

$$CO_0 = CO_{tritium} - \frac{NGA_{RMS}}{C_{NGA-Ar41}} \quad (3)$$

where, $C_{NGA\text{-}Ar41}$ is the calibration factor for Ar-41. Since the average energy of the beta-particle from Ar-41 is about 5 times lager than that from Kr-85, 5 time-larger calibration factor than that for Kr-85 was used [2].

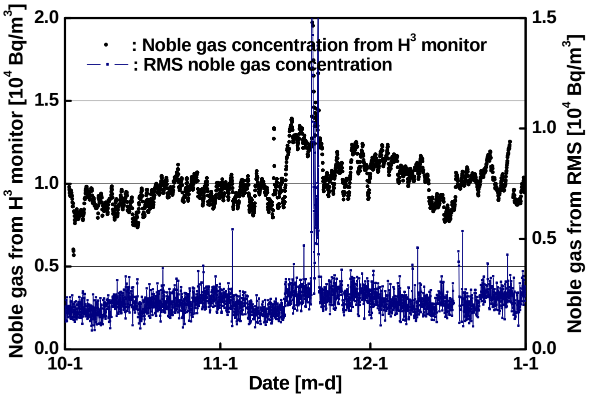

Fig. 2. Concentrations of the noble gas activities from the tritium and RMS monitors.

In order to deduce the background of the tritium channel, we compared the ACO count rate with the tritium concentration deduced by bubbling as in the below figure. The background count rate was deduced to be an intercept of the y-axis in the figure.

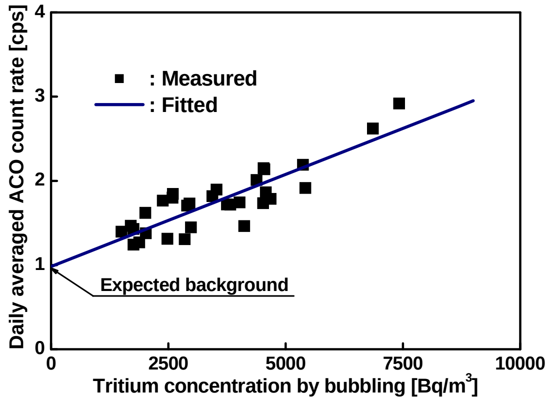

Fig. 3. Deducing the background of the tritium channel.

3. Result

Fig. 4 shows the comparison of the newly deduced tritium concentration with the bubbling data. The tritium concentration was deduced by using the ACO and CO count rates and the newly established backgrounds. As shown in the figure, the two data are fairly consistent with each other even if the statistical deviation of the deduced concentration is big. We expect that the mean in a cycle time would represent the stable value. Thus, it can be concluded that the above evaluation is very useful for the improvement of the data processing of the HANARO tritium monitor.

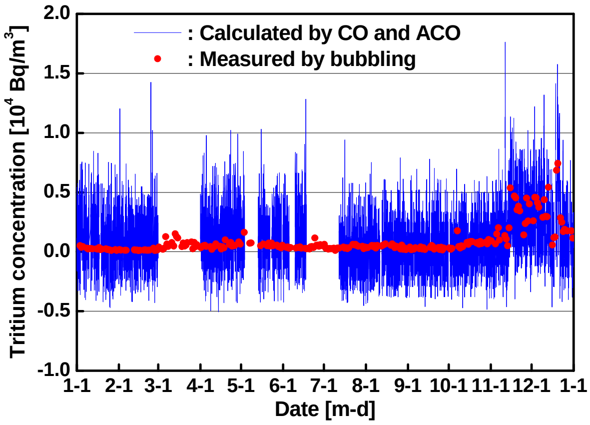

Fig. 4. Comparison of newly deduced tritium concentration with bubbling data.

REFERENCES

[1] M. S. Kim, et al., Sensitivity Analysis for Gaseous Radiation Monitor of HANARO, Autumn Meeting of the Korean Association for Radiation Protection, Jeju, Korea, 2004.

[2] G. F. Knoll, "Radiation Detection and Measurement", John Wiley & Sons, p.45, 2000.