The Annual Environmental Radiation Measurement and Analysis in KOMAC

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1. Introduction

Tritium is a representative low-energy beta emitter, and its risk of internal exposure is low. However, it can be easily absorbed by the skin or ingested orally. The human body contains more than 80% water and the tritium uptake into the body is reacted with the beta rays emitted by the body of water. When water is irradiated, the ionization occurs and primary free radicals are generated. This is relatively large risk of tritium in the internal exposure which cause damage to body tissue in conjunction with a human body component [1] therefore, in the radiation safety team of the Korea Multi-purpose Accelerator Complex (KOMAC), after the test measurement period in the second half of 2017, a sample analysis focusing on the tritium of the water sample, which is generally absorbed into the body from 2018, has been carried out in earnest. The measurement sample is the surface water or rainwater and reservoir water in the site, and tritium is used as an object nuclide. In this research, the tritium is measured and analyzed quarterly using Liquid Scintillation Counter (LSC), and their change trend is checked.

2. Measurement and Result

In order to obtain an accurate measurement value, the calibration is performed on the equipment before the measurement to optimize the measurement capability. Then, an efficiency correction curve for the unknown sample is derived using the standard source. After the calibration of the measuring equipment is completed, the sample measurement is started.

2.1 Calibration of Measurement Equipment

The liquid scintillation counter (LSC) should be calibrated for the mechanical efficiency and the unknown source calibration of the equipment in advance to obtain precise measurements. In this measurement procedure, the tritium was used as the object nuclide. And the machine efficiency calibration of the equipment and the efficiency calibration for the unknown sample measurement were carried out. [2] The machine efficiency calibration aims to maintain the instrumentation performance of the equipment optimally and to confirm the integrity of the equipment operation. In this procedure, the unquenched source (15 ml) in the glass vial form is used as a standard sample. The calibration for the unknown sample is carried out using the Quenched standard Source and the efficiency correlation curve is derived to obtain the measurement efficiency for the unknown sample.

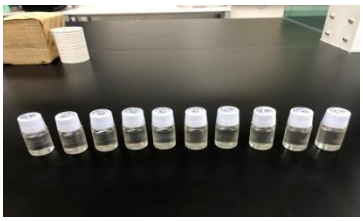

Fig. 1. The Quenched standard Source.

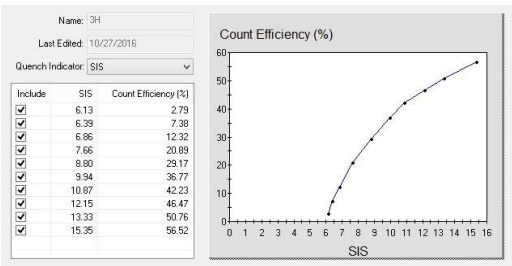

Fig. 2. The coefficient efficiency curve for the spectral index.

2.2. Measurement and Analysis

For the analysis of tritium, a sampling point in the site is designated and samples are taken quarterly. Samples to be used for analysis are collected at designated sites and quantitated in 2 ml using a micropipette. Then 10 ml of scintillator solution has been mixed and the sample for one day has been stabilized. The sample stabilized is measured once every 1800 minutes using the LSC instrument and the Becquerel value for 2 ml of sample is converted to Becquerel per liter (Bq/L). Fig. 3 show the collected samples and the mixed with scintillator solution.

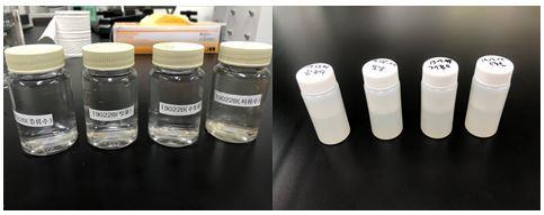

Fig. 3. The collected sample (right) and the sample mixed with scintillator solution.

2.3 Result

For the analysis of tritium in the water in the facility, environmental samples were taken quarterly and the results are shown in Table 1.

Table 1. Quarterly for measurement value of environmental samples (water) in 2018

Sample	1st Quarter [Bq/L]	2nd Quarter [Bq/L]	3rd Quarter [Bq/L]	4th Quarter [Bq/L]
Drinking water	>MDA	>MDA	>MDA	>MDA
Rain water	>MDA	>MDA	>MDA	>MDA
Reservoir	>MDA	>MDA	>MDA	>MDA

The unit of the measured value was converted to the becquerel per liter (Bq/L) in order to compare with the 'Tritium management standard value for each national drinking water'. Fig. 4 shows a comparison of the measured values for each quarter.

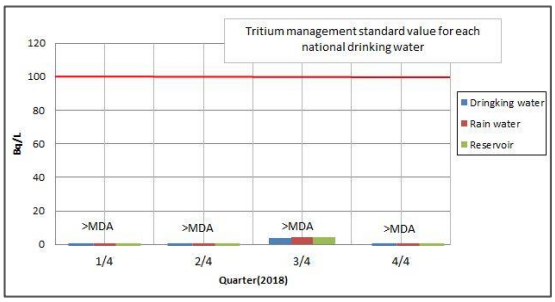

Fig. 4. Comparison of measurement value on site samples (Quarterly).

3. Conclusion

The Radiation Safety team of the KOMAC is measuring and analyzing the tritium value in the water by sampling the environmental samples quarterly as the part of the radiation and radioactivity monitoring in the general environment. As a result of comparing the tritium measurement value of the water samples in the facility quarterly, it was confirmed that it is below the minimum detectable activity (MDA). In addition, it can be seen that it is significantly lower than the European standard, which is the 'tritium management standard value for each national drinking water'

REFERENCE

[1] Osborne RV. Absorption of Tritiated Water Vapour by People. 1966;12:1527-1537.

[2] Michael F.L'Annunziatia, Handbook of Radioactivity Analysis, 3rd edition.