§3. Trial Production of Monitor for Tritium in Vapor of Atmospheric Air

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Safety management of tritium is indispensable for promotion of nuclear fusion research. Monitoring of tritium in air around fusion facilities is one of the most important subjects for safety management of fusion research. However, the minimum detectable concentration (MDC) of conventional tritium gas monitors is higher than the legal limit of tritium in air in work place. Chemical species involving tritium in the atmospheric air are predominantly H_2O, H_2, and CH_4. In those species, the largest in quantity is H_2O as vapor. The purpose of this study is to investigate a feasibility of a real-time monitor for tritium in vapor of atmospheric air.

Figure 1 shows the experimental setup. The flow through type of proportional counter, 130-mm long, 29 mm in inner diameter was made of brass. The anode was made by a tungsten wire of 50 μmφ[1]. First, the remaining air in the system was purged by Ar, and the magnesium column was heated at 550°C. Then water in the evaporating flask was heated to generate water vapor. The water vapor was fed into the magnesium column, and was reduced to hydrogen gas[2]. The gas was desiccated and was drawn into the proportional counter. Change in counts of the proportional counter was collected by a mulchchannel scalor.

At first step, water including natural concentration of tritium was fed in the evaporating flask, and the generated hydrogen with Ar was counted. Next, water of which tritium concentration was 12 kBq cm^{-3} was put into the flask and the vapor was fed into the column. Finally, natural water was put into the flask again. Change in counts is shown in Fig.2. The count rate for the natural water was about 3 cps, which was the background count rate. After the tritiated water was put into the flask, the count rate was exponentially increased and was reached 12 cps at 20-40 min after the tritium injection. The count rated was gradually decreased after the natural water was put into the flask again.

The hydrogen concentration in the counting gas was 1.5%. Considering the hydrogen concentration, the background count rate, and the effective volume of the counter, the MDC for 10 min counting was 0.016 Bq cm^{-3} at atmospheric temperature of 20°C and the relative humidity of 50%. The MDC was one-fiftieth of the legal limit of tritium concentration for work place, i.e., 0.8 Bq cm^{-3}. The MDC for 60 min counting, 6×10^{-4} Bq cm^{-3}, was half of the commercial gas monitor.

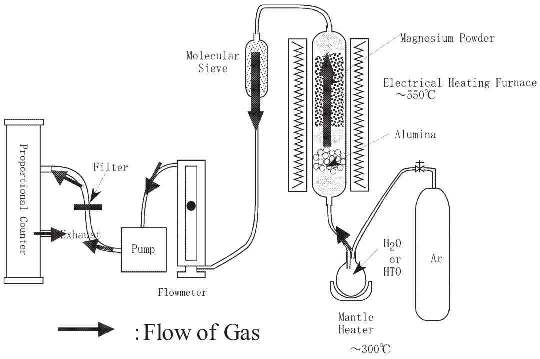

Fig.1. Experimental setup.

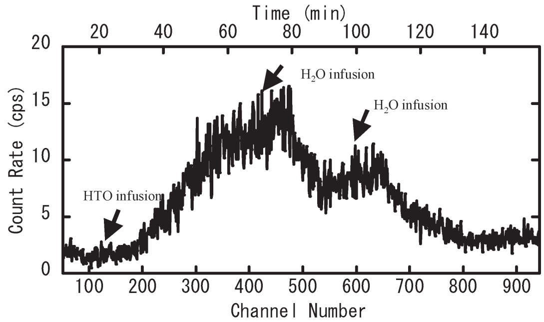

Fig.2 Change in counts.

Tritium on the water vapor in the atmospheric air was measured using a proportional counter by reducing the water to hydrogen. Real-time tritium monitor is feasible by applying this method.

References

1) Ogata, Y. et al.: Proc. 19th on Radiation Detectors and Their Uses. KEK (2005) 177

2) W. W. Bowman and M. B. Hughes, Methods of Low-Level Counting and Spectrometry, IAEA, Vienna, (1981) 353