§6. Integration Test of the Tritium Monitor Using Proton Conducting Oxide as Membrane Separator

Tanaka, M.,
Sugiyama, T. (Nagoya Univ.)

The detection of low level tritium is one of the key issues for tritium management in tritium handling facilities. Various type tritium monitors such as an ionizing chamber, a proportional counter and scintillation type detectors have been developed and utilized for radiation management. However, the monitoring of tritiated water vapor in the presence of other airborne radioactive species such as Rn is difficult. In order to detect such a low level tritium, the separation of Rn and the enrichment of tritium are an effective measure. The application of an electrochemical hydrogen pump using a proton conducting oxide that transports protons in oxides at high temperatures have been proposed as a membrane separator. In previous studies, we have demonstrated the recovery of tritium with extremely low concentration by the proton conducting oxide. As a next step, the integration test of the commercial proportional counter and this hydrogen pump system was conducted at ISL (Isotope Separation Laboratory) in Nagoya University.

The schematic diagram of the tritium monitor combined with proton conducting oxide is shown in Fig. 1. This system mainly consists of proton conducting oxide, metal bellows pump, commercial proportional counter LB110 (Berthold Technology) and data logger LB5320. The extracted tritium from tritium water vapor in argon gas is carried by metal bellows pump and mixed with room air and P-10 gas. Then, the tritium concentration is measured by the proportional counter. The conversion to the supplied tritium concentration from the tritium concentration measured by the proportional counter is expressed by the following equations:

$$C_T = \frac{C_{T_{LB-110}}}{R_T \times \frac{F_a}{F_c} \times \frac{F_c}{200}}, \quad (1)$$

$$R_T = 0.21 \times R_H^3 + 0.37 \times R_H^2 + 0.41 \times R_H + 0.01, \quad (2)$$

where C_T and $C_{T_{LB-110}}$ are the supplied tritium concentration and tritium concentration measured by LB110. F_a and F_c are the flow rate in the compartments of anode and cathode. R_T and R_H are the recovery rate of tritium and hydrogen. The relation between R_T and R_H as shown in equation (2) is determined from the data in ref. 1.

Figure 2 shows the dependence of a partial pressure of water vapor on the extracted tritium concentration in LB110, hydrogen recovery rate and the comparison of converting tritium concentration and supplied tritium concentration. The experimental conditions are shown in the figure. The tritium extraction increases inversely with the square of the water vapor partial pressure. On the other hand, the recovery rate, which is defined as the ratio of the volume of supply water vapor and extracted hydrogen, decreases with the increase of the water vapor partial pressure, because the tritium extraction do not almost vary with water vapor partial pressure. The tritium concentration converted by Eq. (1) has about 15% less than the supply tritium concentration. The difference may be caused by the accuracy of the recovery rate of Eq (2) and measuring instruments, etc.

1) Tanaka, M., et al., Fusion Sci. Technol., **60**, (2011) 1391.

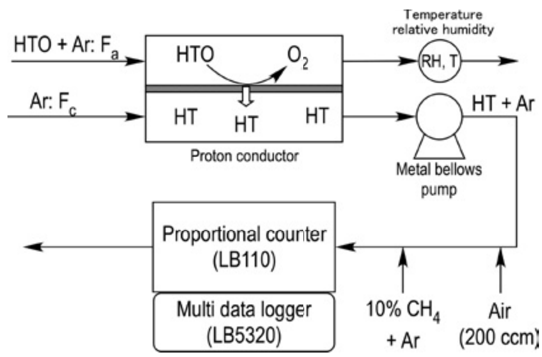

Fig. 1. Schematic diagram of the integration test of tritium monitor and proton conductor.

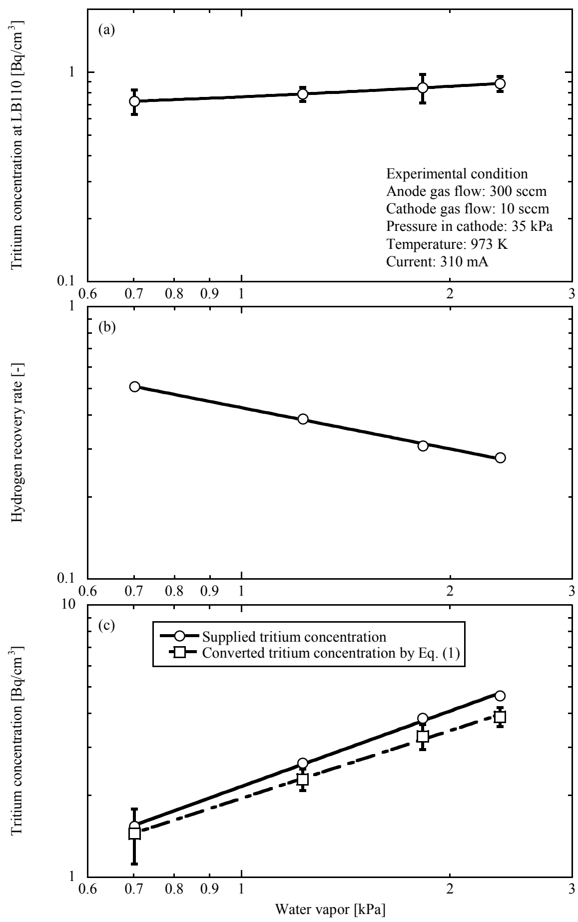

Fig. 2. Dependence of a partial pressure of water vapor on tritium concentration measured by LB110, recovery rate of hydrogen and comparison of converted tritium concentration and supplied tritium concentration.