§2. Tritium Measurement

Sakuma, Y.,
Ogata, Y. (Nagoya Univ.),
Ohta, M., Akiyama, Y. (Niigata Univ.)

1. SUMMARY

In the fiscal year of 2006, we have mainly developed a tritium monitor available to measure the tritium concentration of water vapor, hydrogen and methane separately in the air. The tritium handling laboratory air is composed of many components and three of them usually contain tritium, i.e. water vapor, molecular hydrogen and methane. In order to monitor the tritium concentration in these chemical species, the liquid scintillation counting is put to use. Before the liquid scintillation counting, these tritiated species have to be changed into liquid water. However, this procedure needs much time with a lot of doing and it also takes several hours for liquid scintillation counting itself. In the light of it, we are developing a new monitor, which is able to separately measure the tritium concentrations in these species. This monitor is composed of mainly a water vapor condenser with a water deoxidizer, a high polymer gas permeable membrane module and three ionization chambers. In this paper, we do not mention the measurement of tritium in the water vapor but measurement in the hydrogen gas and methane. According to the results of cold runs and some hot runs, we can say that we can realize a tritium monitor which is measurable at much lower than the control levels.

2. DESIGN OF MONITOR & EXPERIMENT

2.1. Design of Monitor

Based on some literature surveys and our basic studies, we designed a tritium monitoring system shown in Fig. 1. The system takes the air into it through a filter using a pump. The water vapor is removed at first from the air using a condenser and the condensed water is sent to an ionization chamber through a deoxidizer. The dried air is led into a high-polymer gas permeable membrane module which enables to separate the air into two components; a hydrogen rich component and a methane rich component. These two separated components are sent to different ionization chambers to measure the tritium concentrations.

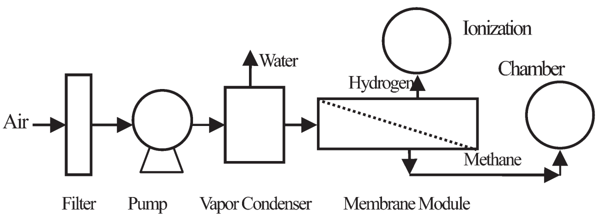

Fig.1 Flow Chart of Tritium

2.2. Measurement of Permeation Coefficients

Using the pure gases of air components, we have measured the permeation coefficients of a hollow high-polymer gas permeable module made by Ube Industries, Ltd. Generally, the permeation coefficients of the air component gases are as follows;

$$H_2 > O_2 > Ar > N_2 > CH_4$$

The results were consistent with them. We measured the values using pure H_2, O_2, Ar, N_2 and CH_4 gases. The hydrogen value was higher than the methane's volume by about 170 times.

2.3. Simulation of Hydrogen and Methane Separation

Based on the measured values, we simulated the separation of H_2 and CH_4 in the air using the membrane module. As was shown in Fig. 2, hydrogen was separated from methane in the permeate and methane was separated hydrogen in the bleed. At the cut of 0.08, the purity of hydrogen in the permeate was 98.2% and the value of methane in the bleed was 99.9%.

2.4. Hot Experiment

We carried out several hot runs, using the CATS (Caisson Assembly for Tritium Safety Study) of the Tritium Process Laboratory (TPL) that is a tritium handling facility of the Japan Atomic Energy Agency Tokai Research and Developing Center. The gas in the caisson was nitrogen containing 49.09 Bq/mL of T_2 without tritiated water vapor nor tritiated methane. Results were shown in Fig. 3, together with the simulation values mentioned above. The experimental values were slightly smaller than simulated values, it is clear however that we can measure separately the tritium concentrations of tritiated hydrogen and tritiated methane in the air, using our proposed monitoring system.

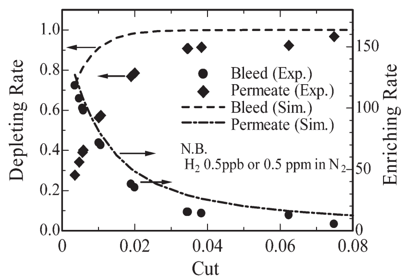

Fig.2. Separation of T_2

3. CONCLUSION

We can separately measure the concentration of the tritiated hydrogen and tritiated methane in the air, using the high-polymer membrane module and ionization chambers.