

## §6. Tritium Separation from Heavy Water Using Electrolysis

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The effective practices for the tritium separation from heavy water are desired for the fusion technologies. Several processes for the tritium separation have been developed, e.g., distillation, chemical exchange, catalytic exchange, and electrolysis 1,2). Electrolysis has advantages that the method has a high separation factor ( $SF$ ), and can be performed using small-scale instruments in a laboratory. The electrolysis, however, has some problems such as needing an addition of electrolyte, and producing the detonating gas. Recently, an electrolysis using a solid polymer electrolyte (SPE) has been developed 3,4). By this electrolysis, no electrolyte is needed to resolve, and the produced hydrogen and the oxygen gases are separately emitted. The electrolysis with the SPE has been used for the tritium enrichment for the estimation of the environmental tritium concentration 3-5). However, the tritium separation from the heavy water using the electrolysis with the SPE had not been reported. The purpose of this study is to investigate the fundamental characteristics of the tritium separation from heavy water using the electrolysis with the SPE.

The electrolysis cell consists of two dimensionally stable electrodes (DSE), and the SPE (0.43mm thickness, Nafion, DuPont) that is placed between the DSEs. The anode is made of a sintered porous titanium plate, and the cathode is made of a sintered porous SUS (SUS316) plate. As the electrolysis sample, heavy water ( $\sim 15 \text{ Bq g}^{-1}$ ) and light water ( $\sim 70 \text{ Bq g}^{-1}$ ) were prepared. The electrolysis were carried out at  $20 \text{ A} \times 60 \text{ min}$ , during the cell temperatures were kept at 10, 20, and 30 °C, only when the temperature was 5°C, the experiment was carried out at  $15 \text{ A} \times 80 \text{ min}$ . The hydrogen and oxygen gases were recombined using a palladium catalyst at 300 °C. Before the recombine,  $4 \text{ L min}^{-1}$  of nitrogen gas was added to the produced gases for a carrier. The recombined water was collected using a cold trap. The activity of the pre-electrolysis sample water and post-electrolysis one, and that of the recombined off the gases were analyzed using a liquid scintillation counter. The apparent  $SF$  was calculated as

$$SF = \frac{\bar{S}_{Cell}}{S_{Rec}} \quad (1)$$

where,  $\bar{S}_{Cell}$  is the mean tritium specific activity of the pre-electrolysis and the post-electrolysis sample water, and  $S_{Rec}$  is that of the recombined off the gases.

The electric potential to flow 20 A was 2-3V. The yields of the recombined water were more than 90%. As the results, the  $SF$  of the heavy water ( $SF_{DT}$ ) in this work was  $2.17 \pm 0.08$ , it was about 1/6 of the  $SF$  of the light water ( $SF_{HT}$ ) as  $11.9 \pm 1.7$ . The  $SF$  value was in a good agreement of the results in the other works 5-12). The  $SF$ s versus the cell temperature were illustrated in the Fig.1. The curves show that the  $SF$  increased with decrease of the cell temperature. The temperature dependence of the  $SF_{DT}$  was smaller than that of the  $SF_{HT}$ . Although the experiment condition was the same except the sample, the fluctuation of the  $SF_{HT}$  was obviously larger than that of the  $SF_{DT}$ . One of the reasons is considered that the  $SF_{HT}$  value was larger than the  $SF_{DT}$  value. The other is considered as the change in the concentration of the heavy water.

The electrolysis using the SPE is applicable for the tritium separation, and is able to perform the small-scale apparatuses at the room temperature.

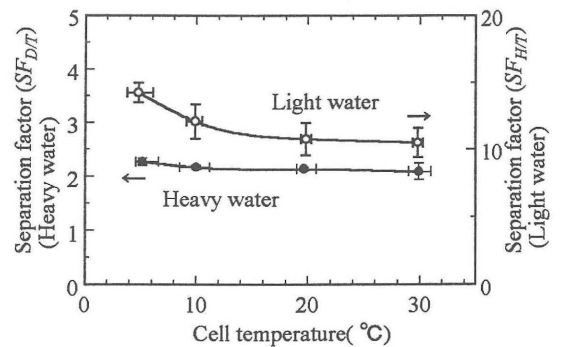


Fig.1 : Separation factor of heavy water and light water.

### References

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