§8. Electrode Dependence upon Separation Factor for Separating Tritium from Heavy and/or Light Water by Electrolysis

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Introduction

The effective practices for the tritium separation from heavy and/or light water are desired for various phases of the fusion technologies [1]. Authors have been investigated the mechanism of the tritium separation by electrolysis using a solid polymer electrolyte (SPE). It had been known that the tritium separation factor (*SF*) depends upon the material of the electrode, especially the cathode [2]. Capable and stable material for the cathode was desired for effective tritium separation. In this study tritium was separated from heavy and/or light water by the SPE electrolyte using three kinds of cathodes; i.e., stainless steel (SUS), nickel (Ni), and carbon (C), and the electrode dependence upon the separation factor was compared.

Materials and Methods

Heavy and/or light water spiked with tritiated water were electrolyzed using an SPE electrolyte device (Tripure XZ001, Permerec Electrode inc.) The electrolysis cell consisted of two dimensionally stable electrodes (DSE), and an SPE (0.43mm thickness, Nafion, DuPont) interposed between the DSEs. The anode was made of a sintered porous titanium plate. The cathodes used were made of a sintered porous SUS (SUS316), Ni, or C plate. The cell was placed in a chamber to control the cell temperature by air-cool, and a radiator was attached on the cell. The tritium concentrations were ~15 Bq g^{-1} (heavy water) and ~70 Bq g^{-1} (light water.) The electrolysis was carried out at 20 A × 60 min at 10, 20, and 30 °C of the cell temperatures, and at 15 A × 80 min at 5°C. As a carrier, 4 L min^{-1} of nitrogen gas was added to the produced hydrogen and oxygen gases, and the gases were fed to a palladium catalyst for recombining. 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. More than ten experiments were performed at a temperature. The apparent *SF* was calculated as

$$SF = \frac{\overline{S}_{Cell}}{S_{Rec}} \qquad (1)$$

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

Results and discussion

The mean yield of the recombined water was 95%. The tritium separation factor of the heavy water ($SF_{D/T}$) was ~2. As shown in the figure, the $SF_{D/T}$ was slightly increased in the order of Ni, SUS, and C. The *SF* of the light water ($SF_{H/T}$) was ~12. The $SF_{D/T}$ of Ni cathode was similar to that of SUS one, and was barely smaller than that of C cathode. For all of the cathodes, the *SF* was decreased with increasing of the cell temperature. The temperature dependence of the $SF_{D/T}$ was smaller than that of the $SF_{H/T}$. The *SF* values were in a good agreement of the results in the other works [3]-[8]. Although the experiment condition was the same except the sample, the fluctuation of the $SF_{H/T}$ was obviously larger than that of the $SF_{D/T}$. One of the reasons is considered that the $SF_{H/T}$ was larger than the $SF_{D/T}$. The other is considered as the change in the concentration of the heavy water. Unanticipatively, carbon was more effective than the other materials.

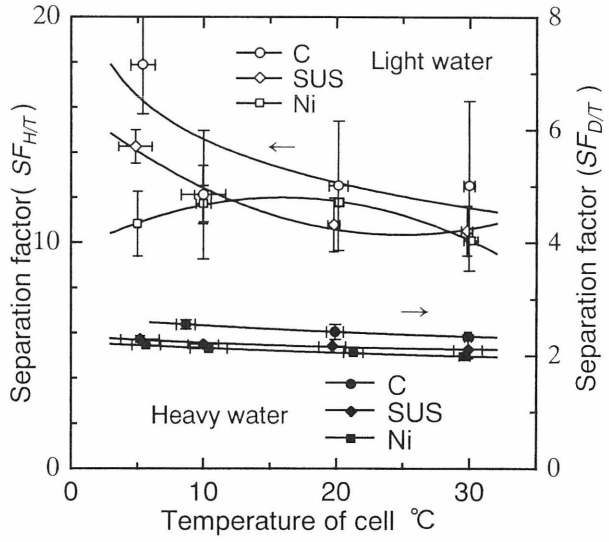

Fig.1 : Separation factor of heavy and light water.

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