TRITIUM RECOVERY FROM BLANKET SWEEP GAS VIA CERAMIC PROTON CONDUCTOR MEMBRANE OF ELECTROCHEMICAL HYDROGEN PUMP

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In case of a solid breeder blanket, tritium bred will be purged out from the blanket by passing a helium based sweep gas through the breeder zone. Use of an electrochemical hydrogen pump having ceramic proton conductor membrane have been proposed for tritium recovery from the sweep gas [1]. Hydrogen pump can extract hydrogen isotopes from a sweep gas selectively, because one of its driving forces of hydrogen transportation is electric potential difference. Its hydrogen or deuterium transportation properties have been investigated so far [2]. However, actual sweep gas will contain H_2, HT and water vapor because of hydrogen addition to the sweep gas. So, in this time, transportation properties of multi-component hydrogen isotopes including tritium were investigated.

The hydrogen pump was double tube structure having ceramic proton conductor membrane as inner tube. The proton conductor membrane used in this work was $SrCe_{0.95}Yb_{0.05}O_{3-\alpha}$ made by TYK Co. The shape was test tube. And its size was 105 mm in length, 12 mm in diameter of outside and 1 mm in thickness. Porous platinum electrodes were pasted on the outside and inside surface of ceramic until 50 mm from the closed end in axial direction. The simulated sweep gas included H_2-D_2 or HT-H_2, and it was fed to the inside of the tube with 0.1-0.4 *l*/min of the flow rate. The outside of the tube was purged by helium gas with 0.2-0.4 *l*/min of the flow rate. The concentration of hydrogen isotopes in the feed gas was about 10000 ppm. In case of the cold experiment (H_2-D_2), its composition was changed. In case of the tritium experiment, H/T ratio was about 13000. The experimental temperature was 873 K. The voltage was applied to the electrodes to move hydrogen isotope from the inside to the outside of the tube in the range between 0-1000 mV. The electric current between the electrodes was measured, and concentration of hydrogen isotopes in the effluent gas was also measured with gas chromatograph and ionization chamber.

Figure 1 shows the relation between the ratio of the transfer rate via the membrane and the composition of the feed gas in the H_2-D_2 system. The broken line shows that the diffusion process in the bulk of ceramic is a rate control step of hydrogen isotope transportation. It was supposed that hydrogen isotope transportation was controlled by diffusion when the applied voltage became higher. In the tritium experiments, the amount of H_2 was much larger than tritium. Therefore, transportation of tritium might be influenced by the transportation of H_2. However, it could not confirm clearly from the observations.

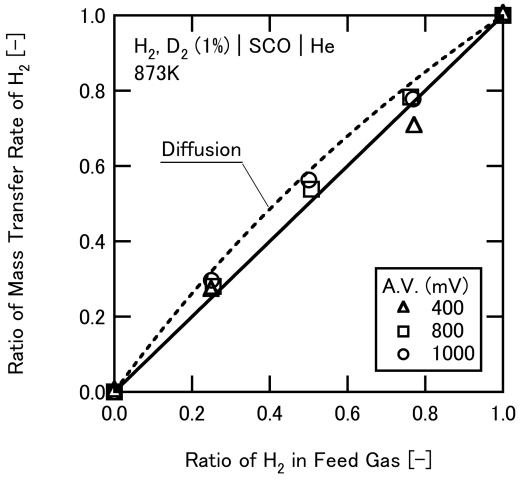

Figure 1: Relation between the ratio of the transfer rate via membrane and the composition of the feed gas.

[1] T. Kakuta et al., Fusion Technol., 39 , 2001, 1083.
[2] Y. Kawamura et al., Nucl. Fusion, 49, 2009, 055019.