

§4. Water Detritiation by Water-hydrogen Chemical Exchange

Sugiyama, T., Yamamoto, I., Miyata, A., Suzuki, E., Miyahara, N. (Nagoya Univ.), Tanaka, M., Uda, T., Asakura, Y.

Experimental studies on hydrogen isotope separation by a Combined Electrolysis Catalytic Exchange (CECE) have been carried out in order to apply it to the system of water detritiation for fusion reactors. The purpose of the present study is to demonstrate separation of tritium from hydrogen using a CECE device on the basis of the previous results for deuterium and hydrogen.

i) Measurement of the catalytic activity for H-T isotope exchange

The Kogel catalyst, which was supplied by Ganz Chemical Co., Ltd. and consists of 1.0 wt% Pt deposited on styrene-divinylbenzene copolymer was used. The experimental apparatus is shown in Fig. 1. The reactor column was a Pyrex glass tube with 25 mm internal diameter. Hydrogen gas from the cylinder was mixed with tritiated water vapor in a humidifier and then supplied from the bottom of the column. The concentrations of HTO in the liquid samples were measured using a liquid scintillation counter.

The values of ϕ_c were obtained by the analytical solution as

$$\ln \phi_c = -kt_0 S_r,$$

where $1-\phi_c$, k , t_0 , S_r are reactive ratio, overall mass transfer coefficient, mean residence time and specific surface area of catalysts, respectively. Analyses of the data for various catalyst diameters, temperatures and flow rates of hydrogen gas gave the value $k = 5.6 \pm 0.3$ cm/s, as shown in Fig. 2.

ii) Separative analyses of a chemical exchange column at total reflux condition

Separative analyses were performed with the Channelling stage model which was originally developed through analyses and experiments with hydrogen-deuterium system.

The column was a random-packed bed of Kogel catalysts and Dixon gauze rings with 25 mm internal diameter and 60 cm length. The operating pressure was 101 kPa and the flow rate of hydrogen gas was 6 l/min. Separation factor of the column was defined as

$$\alpha\beta = C_{\text{Extracted water}} / C_{\text{Extracted hydrogen gas}},$$

where C is the mole fraction of tritiated components in the samples. As shown in Fig. 3 the values of $\alpha\beta$ have maximums and clearly there are the optimal values in the catalyst packed ratio for each operating temperature. The present analyses indicate that the best operating temperature was 60 °C at total reflux condition.

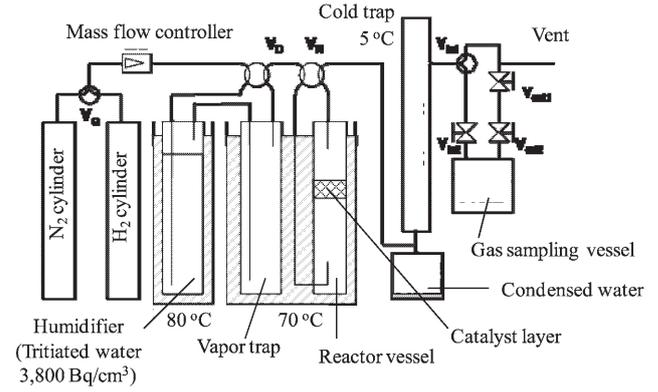


Fig. 1: Experimental apparatus for measurement of catalytic activity

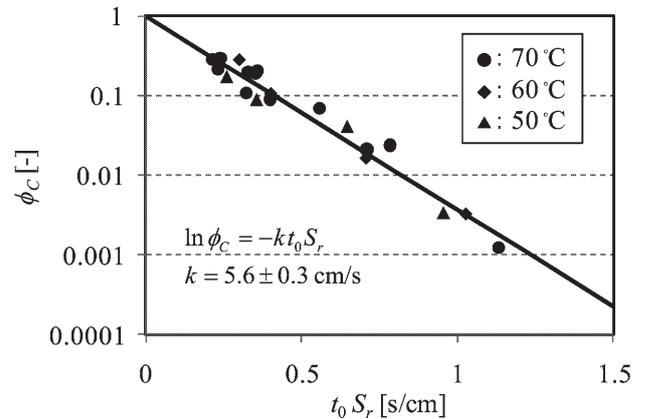


Fig. 2: Correlation between $t_0 S_r$ and ϕ_c

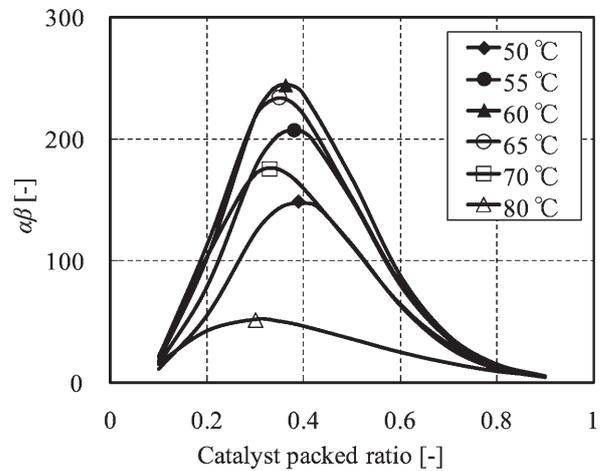


Fig. 3: Separation factors for various temperature and catalyst packed ratio

- 1) Sugiyama, T. et al.: *Fusion Eng. Design*, 83, pp. 1442-1446 (2008).
- 2) Sugiyama, T. et al.: *Fusion Eng. Design*, 83, pp. 1447-1450 (2008).
- 3) Suzuki, E. et al.: *Proc. AESJ Fall Meeting 2008*, Q61, Kochi, September (2008).
- 4) Suzuki, E. et al.: *The 7th Symposium on Isotope Science and Engineering from Basic to Applications*, P9, Yokohama, March (2008).