## §2. Advancement of Water-Hydrogen Chemical Exchange Apparatus by Introducing Trickle Bed Reactor

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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.

In order to improve the separative performance of the CECE process we have examined separative performances of trickle-type packed beds. In the previous study we found that 1) the homogeneously packed bed was more efficient than the layered packed bed, and that 2) there was an optimal quantity of the catalyst which gave a maximum value of separative performance.

The purpose of the present study is to investigate experimentally effects of the gas-liquid ratio on the optimal quantity of the catalyst using with a homogeneously packed bed.

i) Experiments

The reactor column is a Pyrex glass tube with 25 mm internal diameter and 60 cm length. The column is filled with Kogel catalysts (1.0 wt% Pt deposited) and Dixon gauze rings. These packings are shown in Fig. 1. The catalyst packed-ratio is defined as follows.

$$\text{Catalyst packed - ratio} = \frac{\text{Grain volume of the catalyst}}{\text{Grain volume of all the packings}}$$

Grain volumes mean the volume of sphere with average diameter of the Kogel catalyst and the volume of cylinder which has the outer shape same as a Dixon gauze ring.

Hydrogen-deuterium isotope separation with the CECE equipment was performed at 101 kPa, 343 K for various values of the catalyst packed-ratio and for various values of the gas-liquid ratio. Table 1 shows flow rates of fluids in the column. The concentrations of HD or HDO in gas or liquid samples were measured using a stable isotope ratio mass spectrometer (MAT252, Thermo Finnigan).

ii) Separation factors of the packed beds

Total separation factor of the column, $\alpha\beta$, is defined as follows with the molar concentration of deuterated molecule $C$ :

$$\alpha\beta = C_{(\text{Extracted water})} / C_{(\text{Extracted hydrogen gas})} .$$

Calculated total separation factors are plotted against catalyst packed-ratio in Fig. 2. When the value of $G/L$ is 1.7 total separation factors are relatively small and the optimal value of the catalyst packed-ratio can not be found. On the other hand, when the values of $G/L$ are 0.9 and 0.7 the values of $\alpha\beta$ have maximums and clearly there are the optimal values of the catalyst packed-ratio. The optimal value for $G/L = 0.9$ is slightly smaller than the value for $G/L = 0.7$.

In the present study, we found experimentally that the optimal quantity of the catalyst is affected closely by the gas-liquid ratio. To know a quantitative correlation between these two parameters is future tasks.

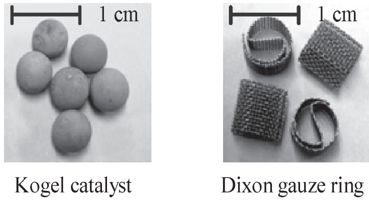


Fig. 1: Packings filled in the column

Table 1: Flow rates of fluids in the column

| | | | |
|---|---|---|---|
| Hydrogen gas ($G$) [mol/h] | 20 | 20 | 20 |
| Water vapor ($V$) [mol/h] | 8.4 | 8.4 | 8.4 |
| Liquid water ($L$) [mol/h] | 11.4 | 21.6 | 28.2 |
| Gas-liquid ratio ($G/L$) [-] | 1.7 | 0.9 | 0.7 |

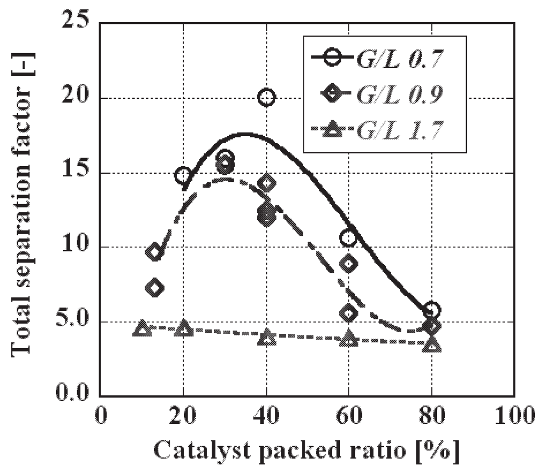


Fig. 2: Separation factors of the homogeneous bed for various catalyst packed-ratios and for various gas-liquid ratios

Reference

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