§5. Studies of Tritiated Water Vapor Removal with a Hollow-filament Type Polyimide Membrane Dehumidifier

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1) Introduction

In future DD experiments for LHD devices, it is important to establish the removal technique of tritium produced in vacuum vessel by DD reaction. In this collaborative study, the acquirement of dehumidify characteristics for a membrane type dehumidifier and theoretical study was done for achievement of high performance dehumidify compared to molecular sieve method. In this fiscal year, simulation study using perfect mixture model was performed. These results were compared to the achieved data at NIFS and discussed.

2) Model

There are lots of simulation model proposed for analyzing gas separation behavior using a membrane type dehumidifier. In particularly, it is well known that the combination of counter-flow and cross-flow model is the most ideal model. However, some specific parameters related to membrane are required and it is difficult to find out these specific parameters. To avoid these problems, we adopted the model of two component mixture gases. Fig. 1 shows schematic drawing of gas stream inside of a membrane module. In this figure, F_f [mol/s] is supply mixture gas flow rate, and x_f, x_o and x_p are, respectively, mole fraction of inlet, high pressure outlet and low pressure outlet gas stream of each component. The gas component

$$y_p = \frac{(\alpha-1)(\phi+x_f)+1-\sqrt{\{(\alpha-1)(\phi+x_f)+1\}^2-4\phi(\alpha-1)\alpha x_f}}{2\phi(\alpha-1)}$$

for outlet side was expressed by the following equation,

In this equation, ϕ is an operation factor, and explained in the following equation.

$$\phi = \gamma + \theta - \gamma\theta$$

where, θ is a cut rate and γ is a pressure ratio.

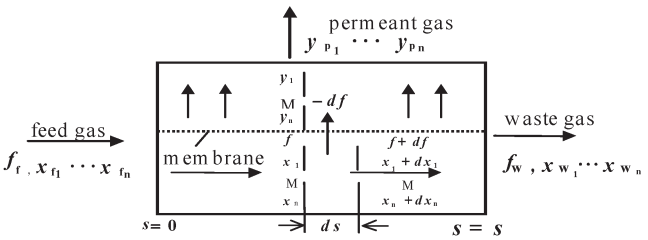

Fig.1 Schematic drawing of membrane module

3) Results and discussion

Fig.2 shows the experimental results of recovery rate as a function of cut rate, which was achieved using polyimide type dehumidifier produced by Ube Industries, Ltd. [1]. The calculation result using the complete mixing model was also shown in this figure.

It was found that the recovery rate of the experimental result was exceeded over 99 % under the cut rate of 0.2. However, only 30 % was achieved by the calculation result. It is also known that the good agreement was found between experimental results and calculation ones for the hydrogen isotope separation. These facts indicate that the permeation rate in membrane would give a large influence for water vapor separation, although it was assumed to be constant in this model.

Further study on the evaluation of permeation rate in membrane will be done and optimized model for water vapor separation will be established.

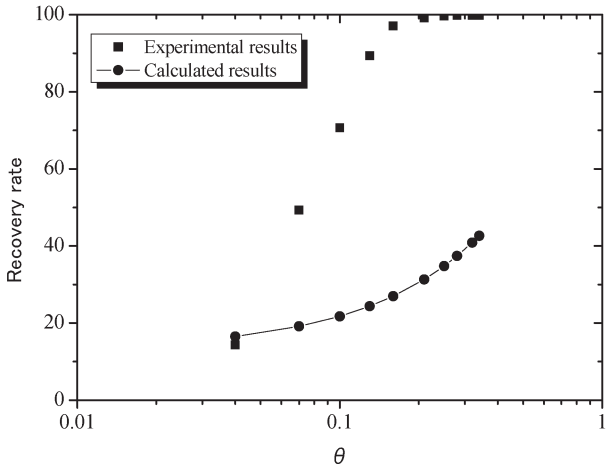

Fig.2 Correlation between recovery rate and cut rate

4) Conclusions

To establish suitable water vapor separation system for DD experiment in LHD device, the experimental data was achieved at NIFS and these data were compared to the calculation one using perfect mixture model. It was found that the inconsistency was found between the experimental result and calculation one and these facts indicated that the permeation rate in membrane would give a large influence for water vapor separation.

References

1) Asakura, Y., *et al.*: *Fusion Sci. Technol.*, 48 [1], pp. 401-404 (2005).