§5. Study on Polyimide Hollow Fiber Membrane Type Dehumidifier for Tritium Removal

Okuno, K., Oya, Y. (Fac. of Sci., Shizuoka Univ.),
Asakura, Y. (LHD)

1) Introduction

In future DD experiments for LHD, 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. Simulation study using complete mixing model was performed in the last fiscal year. However, the simulative and experimental estimations of the water recovery ratio from the membrane could not be agreed with each other. Therefore, in this fiscal year, critical factor of this disagreement was considered and analyses using alternative simulation were attempted and discussed.

2) Model

There are many simulation models proposed for analyzing gas separation behavior using a membrane type dehumidifier. 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 some of them are hard to determine. To avoid these problems, we firstly adopted the complete mixing model. However, the simulation of that model could not reproduce the experimental results for water vapor separation because the permeation rate of water vapor was constant in that model. Therefore, we adopted the counter-flow model as the next step. Figure 1 shows the schematic drawing of gas stream inside of a membrane module. In this figure, F_f [mol/s] is mixture gas flow rate of supply side, and x_f, x_o and x_T are mole fraction of inlet, high pressure outlet and low pressure outlet gas stream of each component, respectively.

3) Results and discussion

Figure 2 shows the comparison of the experimental results for water vapor separation in NIFS and the simulation results for counter-current flow model. From this figure, it was found that the simulation results for that model agreed with that of the

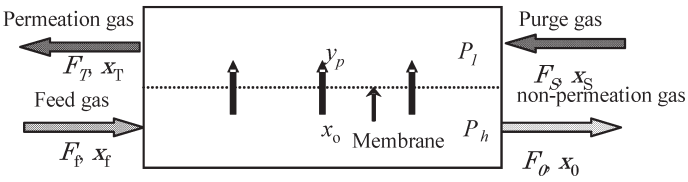

Fig. 1 The schematic drawing of gas stream inside of a membrane module.

experimental results. In our previous study, gas separation for basic component of air such as N_2, O_2, and CO_2 could be reproduced by using the simulation for complete mixing model. These results suggested that the difference of the separation for basic component of air and water vapor derived from the permeation mechanism. The difference of the separation mechanism was attributed to that of the driving forces, which that of the separation of basic component of air was contributed to the partial pressure, while that of water vapor was contributed to the molecular diffusion and adsorption on membrane surface. According to these results, it was expected that recovery rate in the counter-current model was more appropriate than that in complete mixing model.

4) Conclusion

To simulate the separation of water vapor, we adopt the counter-current flow model in this study. The simulation results showed good agreement with the experimental results. According to these studies, the separations of air and water in steady operation vapor were reproduced. Therefore, taking account for the gas separation during transition period, dehumidifier properties of nonsteady operation will be studied in detail in the future work.

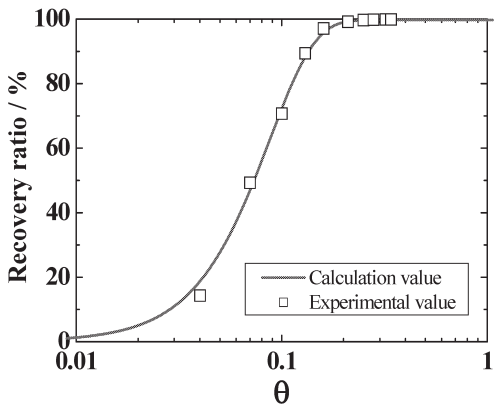

Fig. 2 The comparison with the experimental results for water vapor separation in NIFS and the simulation results for counter-current model.