Separation of $H_2{}^{17}O/H_2{}^{18}O$ with Hydrophobic Membranes

Jaewoo Kim*, Sang-Eon Park, Taek-Soo Kim, Do-Young Jeong,
Kwang-Hoon Ko, and Kyung-Bae Park**
*Lab for Quantum Optics, ** Division of HANARO Application,
Korea Atomic Energy Research Institute, Yusung, Daejeon, Korea 305-353

O-18 stable isotope enriched water (>95%) is used as a target in cyclotron for the production of β-emitter radioisotope F-18 whose half-life is about 1 hour 50 minutes. Produced F-18 is used for the composition of labeled compound ^{18}F-FDG which is injected into the patients prior to PET (Positron Emission Tomography) scan. Currently, O-18 is produced by the cold distillation of NO (Nitric Oxide) or fractional distillation of water only in US, Russia, and Israel. Since the oxygen isotope production processes are costly and also restricted for technology transfer, R&D for more efficient and self-reliable O-18 production process has been claimed by the medical industry during the last several years. For the development of an advanced O-18 separation process using water, we experimented the permeation characteristics of the hydrophobic PTFE membranes under the various experimental schemes. Isotope separation coefficients for $H_2{}^{17}O$ and $H_2{}^{18}O$ were measured by diode laser absorption spectroscopy.

Oxygen isotope separation initiated by the membrane distillation of water was firstly observed by A. G.. Chmielewski and W. A. van Hook in 1990.[1] They observed a significant difference of oxygen and hydrogen isotopic concentrations in water vapor permeated from hot water (~ 50 °C) flowing on the hydrophobic membranes. Measured O-18 isotope separation coefficients for the membrane water distillation ($\alpha > 1.01$) were much higher than that of conventional fractional distillation of water ($\alpha \sim 1.003$). Since isotopic separation is caused by gaseous diffusion in membrane pores, air already filled in membrane pores must have some effects on water vapor diffusion. However, the experiments performed by Chemieleski *et. al.* did not provide the effects of air in membrane pores properly. Also, temperature and pressure dependencies on isotope separations were not clear.[2,3] In this report, we examined the effects of pore air on the separation of oxygen isotopes using thermopervaporation process, which uses vacuum pump to remove air in membrane pores. In this scheme, pressure of the permeate side is assumed to be approximately same with the equilibrium vapor pressure of water at given temperature. We used the flask at room temperature or the cold trap of liquid nitrogen to collect warm water vapor dependent on experimental scheme, while Chemieleski *et. al.* used countercurrent cold water at the permeate side to collect warm water vapor.

Fig. 1 and Fig. 2 show the experimental diagrams of membrane reactor and the diode laser analytical system, respectively. Absorption peaks of each isotopic water molecules were

compared using combination band $\nu_1 + \nu_3$ around 1.39 μm region for determination of O-17 and O-18 isotopic abundances in water. Measured isotope separation coefficients of PTFE hydrophobic membrane with pore air were α = 1.001, 1.0023, 1.0028 for $H_2{}^{17}O$ and α = 1.0046, 1.0072, 1.0077 for $H_2{}^{18}O$ at 38 °C, 52 °C, and 66 °C, respectively. Without air in membrane pores, isotope separation coefficient was increased from 1.0072 to 1.010 at water temperature 52 °C as shown in Fig 3. Further information will be presented in the conference.

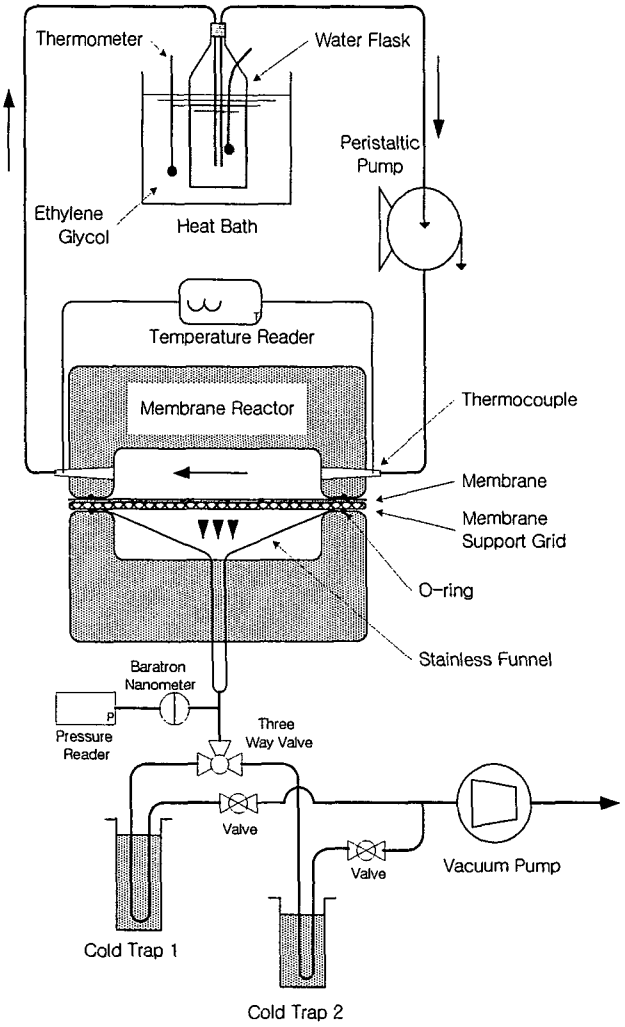

Fig 1. Membrane Reactor System

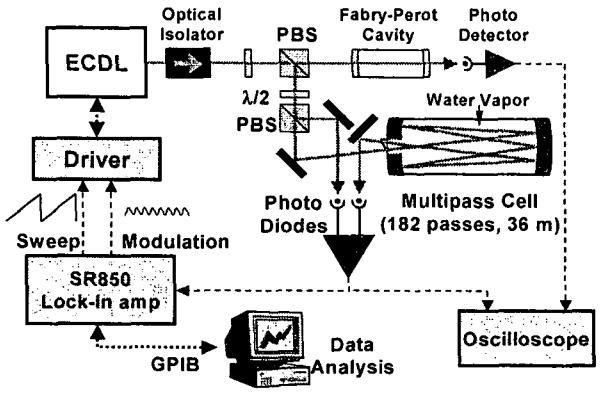

Fig 2. Diode Laser Absorption Spectroscopy System for $H_2{}^{17}O$ and $H_2{}^{18}O$ Analyses

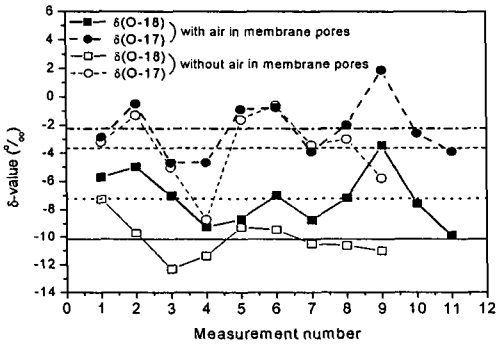

Fig 3. Separation of $H_2{}^{17}O$ and $H_2{}^{18}O$ with and without Air in Membrane Pores

Acknowledgement: This work is being supported by the Mid-Long Term Nuclear Energy Research Program of MOST/ROK.

References

1. W. Alexander van Hook, A. G. Chmielewski, G. Z-. Trznadel, and N. Miljevic, US Patent 5,057,225, Oct. 15, 1991.
2. A. G. Chmielewski, G. Z-. Trznadel, J. Dlutowski, and N. Miljevic, Nucleonika, **34**, 273, 1989.
3. A. G. Chmielewski, G. Z-. Trznadel, N. Miljevic, and W. A. van Hook, J. of Membrane Science, **55**, 257, 1991.