§5. Hydrogen Permeation Transport through Thin FLiNaK Film

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Hydrogen transport characteristic of liquid breeding material is still important issue to be clarified because it has great influence on the blanket system design, especially for the tritium recovery and the permeation leakage reduction. In particular, hydrogen transport phenomena around the liquid/solid (tubing wall etc.) surface including that in thin fluid film are very important. Thus using the experimental device constructed in FY2012, hydrogen transport though thin FLiNaK (LiF-NaF-KF mixed molten salt) film was investigated.

The experimental setup is similar to our previous work performed in FY2012 in which liquid Li-Pb eutectic alloy was used. In this time, 1.0 mm FLiNaK film was sandwiched with pure Ni plates(2 and 1 mm thick) whose outer surfaces were exposed to decompressed hydrogen gas (100~3000 Pa) and evacuated by a high vacuum system respectively. Temperature of the system was kept to be 823 K. Fig.1,2 shows the overview of the experimental system and an example of the hydrogen permeation breakthrough. The transient permeation decrease and increase just after the start and the stop of hydrogen gas supply are due to the thermal balance change by the gas supply.

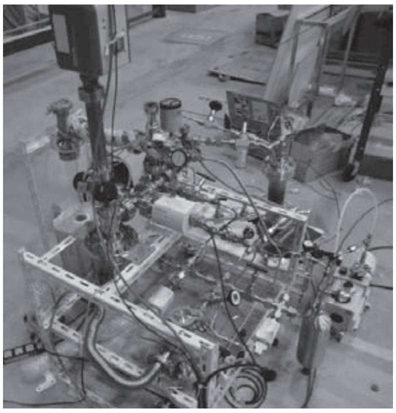

Fig. 1. Overview of the experimental system

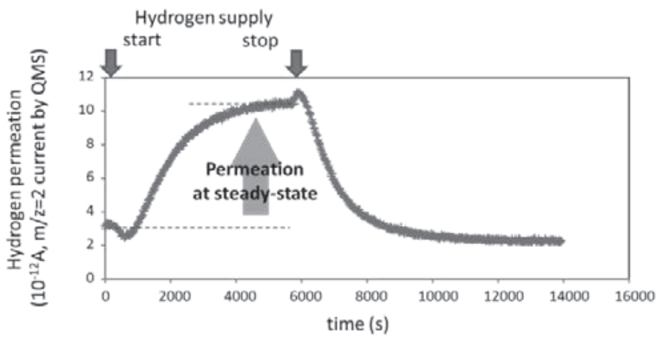

Fig. 2. Example of hydrogen permeation breakthrough.

Hydrogen permeation at steady state, shown in Fig.2, is summarized in Fig.3. The permeation flux increases with the 0.65 power of the hydrogen feeding pressure. This result indicates that both of hydrogen diffusion by atomic state H (in Ni) and diffusion by molecular state H_2 (in FLiNaK) are included as a rate-determining process.

For further discussion, 1D diffusion model was constructed assuming the equilibrium hydrogen distribution at the Ni/FLiNaK boundary, hydrogen molecular diffusion in FLiNaK, and no permeation resistance at all boundaries (adsorption, recombination, etc.). Fitting with this model showed good agreement in some cases as shown in Fig.4, though much improvement is necessary. Permeability of FLiNaK estimated with the model was close to the reported data.

This system is planned to be used in FY2014 for the similar experiment with FLiNaK mixed with metal powder to increase the practical hydrogen solubility

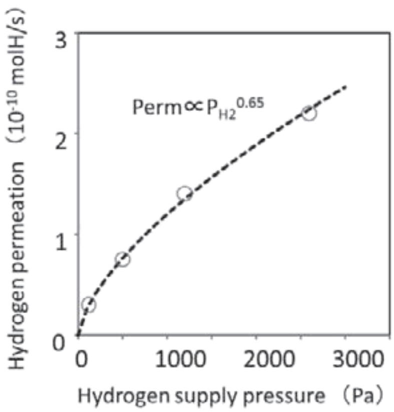

Fig. 3. Steady state hydrogen permeation through Ni/FLiNaK/Ni system at 823 K.

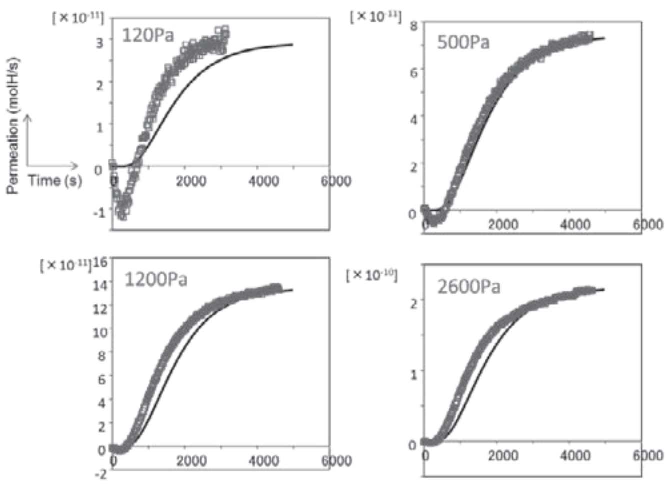

Fig. 4. Breakthrough curve of hydrogen permeation at 823 K with its fitting result by diffusion model