§15. Tritium Relating Properties of Flinabe as a New Candidate for Molten Salt Blanket of FFHR

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Flibe ($2LiF+BeF_2$) was an expected candidate for tritium breeder for the force free helical reactor, FFHR. Although Flibe has attractive properties of low MHD effect due to low electric conductivity, high TBR, high heat transfer ability, it has disadvantages of high melting point (459ºC) and corrosive action to facing materials due to HF production. Since blanket operation is limited between 500 and 600ºC in case of Flibe usage for self-cooled blanket system of FFHR. In order to overcome the disadvantages of Flibe, a new fluoride molten salt, Flinabe ($LiF+NaF+BeF_2$ mixed molten salt, melting point is 305ºC) is proposed here for research target and tritium relating properties are experimentally determined. The reason why Flinabe is selected for a new candidate is that there has never been experimental result on tritium relating properties with still keeping high abilities as a tritium breeder or blanket material similar to Flibe.

At first of experiment, solid components of LiF, NaF and BeF_2 with the specified content of 1:1:1 in molar fraction were melted in a Ni crucible in Ar glovebox and the melting point of 305ºC was confirmed. Then, the Flinabe molten salt was transferred in a middle part of a tertiary cylindrical tube system. The inside tube is supplied with H_2 gas under a constant partial pressure, and the inside of the most outside tube is under Ar purge with constant pressure and a constant flow rate. Tubes contacting with Flinabe are made of monel-400. The diameter and thickness of inside and outside monel tubes are 3.18 mm, 0.6 mm, 12.7 mm and 2.0 mm. The length of the permeation is 53 cm.Hydrogen permeates through the inside monel tube, Flinabe part and the middle monel tube. Permeated H_2 is purged out by Ar and the H_2 concentration in Ar is detected by gas chromatography.

The overall hydrogen permeation system is considered one dimensional in the radial direction. Transient and steady state H_2 permeation rate is measured under constant upstream H_2 pressure and temperature. H_2 solubility, diffusivity and permeability of Flinabe molten salt are determined by fitting numerical calculation based on diffusion equation in Flinabe with permeable walls to experimental history of H_2 permeation rate. Similar experiment is performed using another molten salt of Flibe, Fnabe and Flinak for comparison. Examples of experiment are summarized in Figs. 1 and 2. Fig. 1 illustrates experimental H_2 permeation rate as a function of the upstream H_2 pressure and the overall H_2 permeation is limited by diffusion in Flinabe and by monel at high pressure side.

The following things are clarified from experiment and analysis:

(1) The H_2 permeation through Flinabe is in a form of molecules and the pressure dependence is 1st order.
(2) The H_2 permeation through monel tube is in a form of atom and the pressure dependence is 0.5th order.

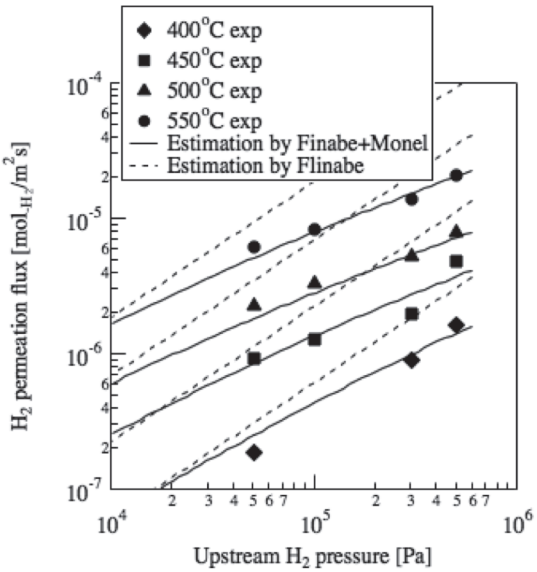

Fig. 1 H_2 permeation through Flinabe in Monel400 tube

(3) The H_2 solubility of Flinabe obeys the Henry law.
(4) The H_2 diffusivity in Flinabe is $6x10^{-10}$ m^2/s and faster than other blanket candidates of Li-Pb.
(5) Since the H_2 permeation rate through Flinabe is affected by monel one, the two permeation is divided. Other results are reported below.

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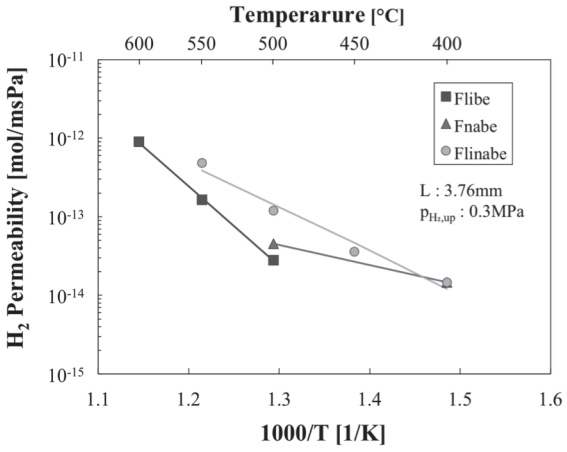

Fig. 2 H_2 permeability through Flibe, Fnabe and Flinabe