§6. Analysis of Tritium Fluoride Behavior and Recovery of Tritium in a Molten Salt Flibe Blanket

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1. Purpose of Study

Flibe is one of the most advanced self-cooled liquid blanket materials for a fusion reactor, *e.g.*, FFHR-2. It is expected that Be can work as a redox-control agent as well as a neutron multiplier. Advantages of Flibe blanket are stable at higher temperatures, low reactivity with oxygen and water vapor, low electric conductivity and so on. Tritium will be generated in Flibe as a form of TF. Since TF is corrosive to structural materials, conversion of TF to T_2 is necessary in a Flibe blanket. Otherwise, we need to recover TF down to an allowable concentration immediately after the blanket outlet. In the present study, we investigate the possibility of a redox control by contact with a Be rod in the Flibe loop of FFHR-2, and the behavior of TF and HT released from neutron-irradiated Flibe.

2. Results and Discussion

(1) Conversion of TF to T_2 in a blanket

The Be dissolution rate and its saturated concentration were determined j_{Be}=1.8x10^{-4}mol-Be/m^{2}s and $x_{Be,sat}$=4x10^{-3} from the JUPITER-II experimental study in 2005. Dissolved zero-charge Be works as a reduction agent for the conversion of HF (TF) to H_2 (T_2). The reduction rate is correlated to a first-order reaction-rate equation as follows:

$$m_{BeF_2} = k_{BeF_2}\left(x_{Be}x_{TF} - \frac{x_{BeF_2}x_{T_2}}{K_{BeF_2}x_{TF}}\right)$$

Fig. 1 shows a comparison of the effluent HF concentration between analysis and experiment using 0.5L Flibe enclosed in a Ni pot. Close agreement was obtained between them.

1 GW fusion power needs to produce 1.6 MCi/day tritium under steady-state operation of a commercial fusion reactor with TBR=1. Flibe flow rate is maintained at 200 m^3/s to keep the temperature difference of T_{in}=500°C and T_{out}=600°C from a viewpoint of Flibe-material consistency. **Fig. 2** shows calculation results of the expected TF concentration in the blanket outlet as a function of the dissolved Be concentration. The predicted TF partial pressure is around 1 Pa.

(2) Recovery of TF and T_2 from Flibe

Fig. 3 shows tritium effluent curves from neutron-irradiated Flibe under a 5%H_2-Ar flow condition. At first isotopic-exchanged HT and then resolved TF were in turn released from Flibe even at 300°C. The result reveals the possibility of direct TF recovery by a He-Flibe extraction tower installed immediately after the reactor outlet.

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3. Studies published or presented in 2005

[1] S. Fukada, R. A. Anderl, T. Terai, A. Sagara, Fus. Sci. Technol., 48 (2005) 666-669.

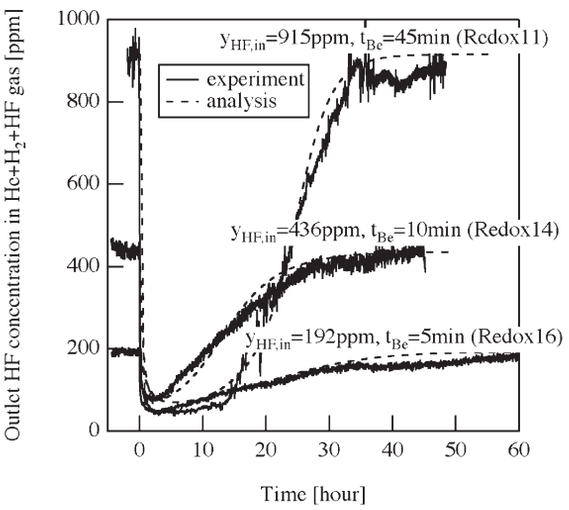

Fig. 1 Experimental results of redox control by Be

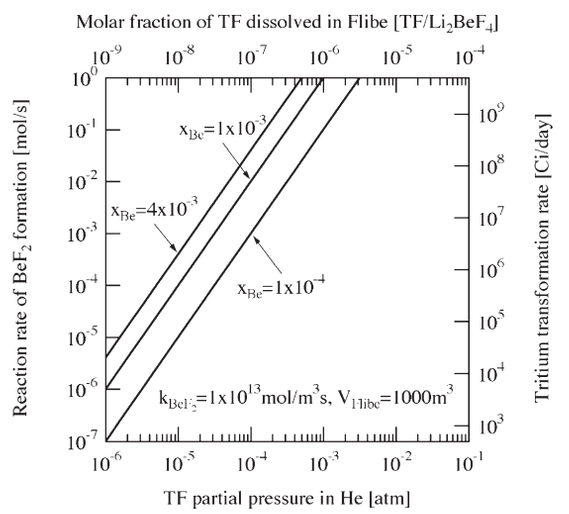

Fig. 2 Tritium concentration in Flibe blanket

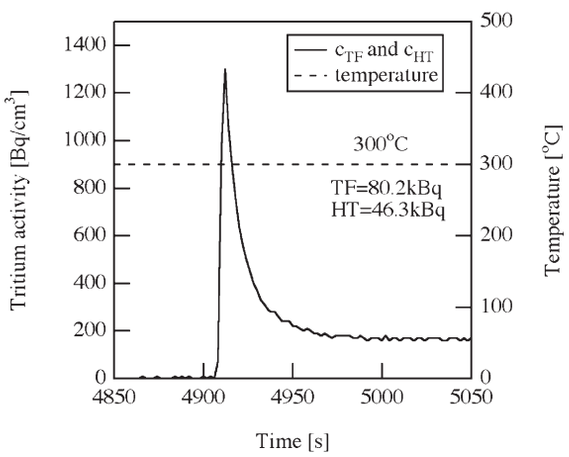

Fig. 3 Tritium released from neutron-irradiated Flibe

[2] S. Fukada, A. Morisaki, A. Sagara, Proc. ISFNT-7, (2005).
[3] S. Fukada, M. F. Simpson, R. A. Anderl, et al., Proc. ICFRM-12, (2005).