§20. Experimental Study of Counter-current Extraction Tower to Remove Tritium in Flibe Blanket Loop of Fusion Reactor

Fukada, S., Edao, Y. (Kyushu Univ.),
Sagara, A., Nagasaka, T.

Efficient extraction of heat and tritium (T) from a self-cooled Flibe (mixed fluoride of LiF and BeF_2) blanket loop is investigated for FFHR-2 helical fusion reactor within a framework of the NIFS-Kyushu University corporative study. Its research target is to give a blanket design to satisfy operating conditions for extraction of heat and T within maximally 600°C corrosion limit and allowed T leak rate of 10Ci/day. Solubility and diffusivity of T in Flibe are the most important data for its design. These data were determined as well as another molten salt called Flinak (mixed fluorides of LiF+NaF+KF) [1,2]. The results are summarized in Fig. 1. The activation energy of diffusivity in Flibe or Flinak depends on its chemical conditions. When Flibe is irradiated by neutron, generated T has a form of TF. On the other hand, when Flibe is exposed under reduced conditions, the chemical form of T becomes HT or T_2. It is proved that solubilities of various gases in Flibe depend on their molecular radius.

Design activities on Flibe blanket study of FFHR-2 completed in FY 2008 are correlated as follows:

(1) Flibe blanket loop is divided to two loop systems, and respective Flibe flow rates, temperature conditions and positions of header and receiver are determined.
(2) The inner Flibe loop with a larger flow rate is designed to cool the first wall lower than 600°C.
(3) The composition ratio of LiF:BeF_2 in Flibe mixed molten salt is accommodated to a lower composition ratio than 2:1, where the melting temperature becomes lower than 459°C of 2LiF+BeF_2.
(4) A counter-current Flibe-He extraction tower recovers tritium generated in Flibe continuously.
(5) The flow rates of He and Flibe and the height of the extraction tower were determined using previous mass-transfer data for the packing material of Dixon Ring.
(6) Tritium leak rate through heat exchanger tubes was estimated, where two mass-transfer resistances on diffusion in Flibe and sus316 tube are taken into consideration.

Papers published in FY2008

[1] Y. Edao, S. Fukada, *et al.*, "Tritium release from neutron-irradiated Flibe purged out by Ar-H_2 or Ar at elevated temperature", Fus. Sci. Technol., 55 (2009) 140-151.

[2] S. Fukada, Y. Edao, *et al.*, "Hydrogen diffusion and hydrogen isotopic exchange on molten salts of mixed fluorides, Flibe (LiF+BeF_2) or Flinak (LiF+KF+NaF)", Proc. Joint Symposium on Molten Salts, (2008) 875-880.

[3] A. Sagara, O. Mitarai, *et al.*, "Optimization activities on design studies of LHD-type reactor FFHR", Fus. Eng. Des., 83 (2008) 1690-1695.

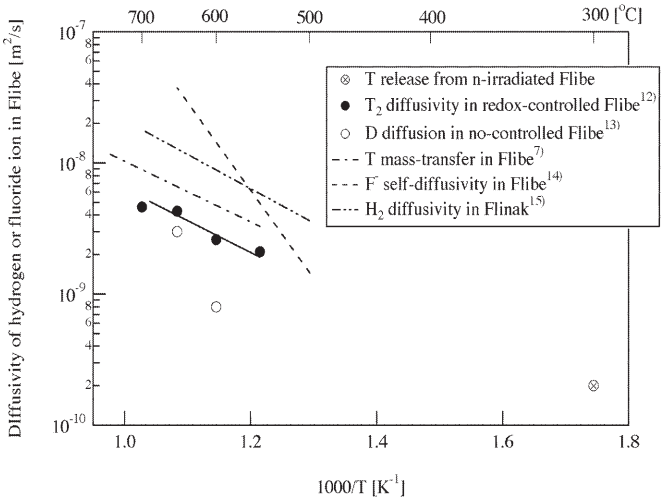

Fig.1 Tritium diffusivity in Flibe and Flinak

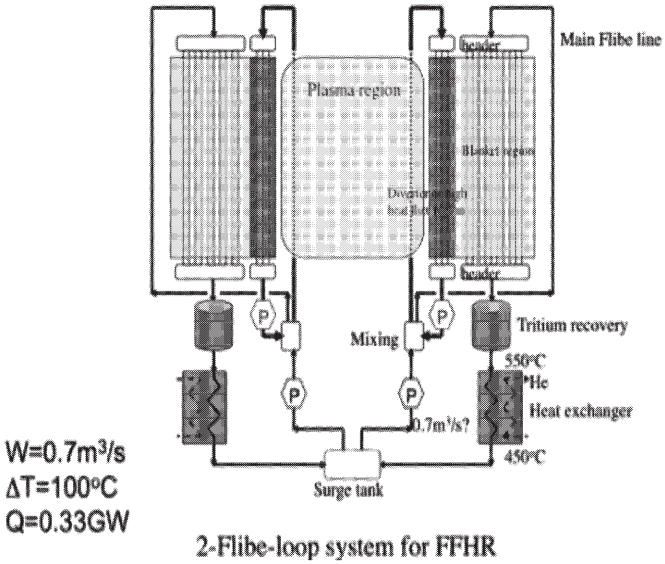

Fig. 2 Two-Flibe-loop system of FFHR

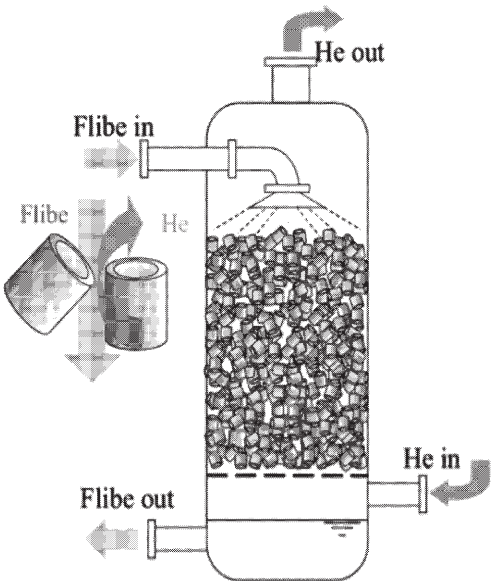

Fig.3 Counter-current Flibe-He extraction tower