§36. Experimental Study on Tritium Recovery and Permeation from LiPb Blanket Loop for Laser Fusion Reactor

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The first wall of a laser fusion reactor is exposed to strong neutron irradiation. In order to achieve protection from neutron damage, sufficient cooling of the wall and tritium breeding, wet-wall concept of LiPb flowing is designed for the KOYO-first reactor. $Li_{17}Pb_{83}$ eutectic alloy has several advantages for a falling liquid film as follows: (1) high T breeding ratio, (2) low Li vapor pressure, (3) comparatively high T equilibrium pressure, (4) comparatively lower melting point, (5) good thermal conductivity, (6) good compatibility with structural materials and (7) less radioactivity except for T. Therefore, it is considered the most promising candidate. In the present study, H or D permeation behavior in LiPb under thermal convection conditions was experimentally investigated. In addition, the overall tritium behavior in the recovery loop of the LiPb breeding coolant is analytically investigated.

Our research group has investigated the behavior of hydrogen isotopes permeation through LiPb under a static condition. The values of solubility, diffusivity and permeability were presented and its isotope effect was clarified. As seen in the Fig. 1, LiPb flows from the top to the bottom of the first wall chamber of a laser fusion reactor, and the loop includes T recovery system and heat recovery system. In order to determine the effect of LiPb flowing quantitatively, the hydrogen permeation rate through LiPb with thermal convective flow is investigated using an experimental apparatus shown in Fig. 2. LiPb is exposed to two different temperatures and to hydrogen pressures in a sus316 enclosure. The rate of the overall H_2 permeation from the lower region to the top one is determined.

Fig. 3 shows typical experimental results of H permeation through LiPb under thermal convection. The temperature of the lower part is 600°C, and the upper part one changes from 300 to 600°C. Each permeation rate increases from zero to a steady-state value with time elapse. The transient time decreases with the increase of temperature difference, and the steady-state values increase with it. Therefore, the H permeation rate is affected not only by intrinsic permeability of sus316 tube but also by the convection flow of LiPb. LiPb is under turbulent flow judging from the dimensionless Rayleigh number. Analytical simulation that takes thermal convection of LiPb and permeation through sus316 into consideration is also performed. The results are presented in the international workshop related with fusion-tritium system.[1)]

1) Okada, M. *et al.*: Proc. of Japan-China workshop, J. Appl. Nucl. Sci. Technol., 5 (2012) 117-121.

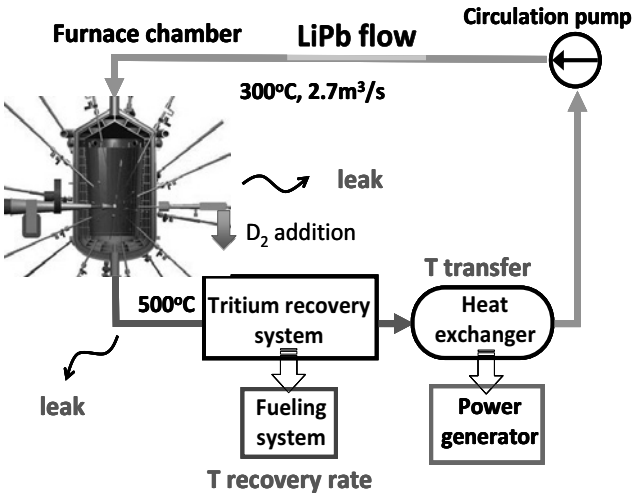

Fig. 1 $Li_{17}Pb_{83}$ tritium recovery loop for KOYO-fast

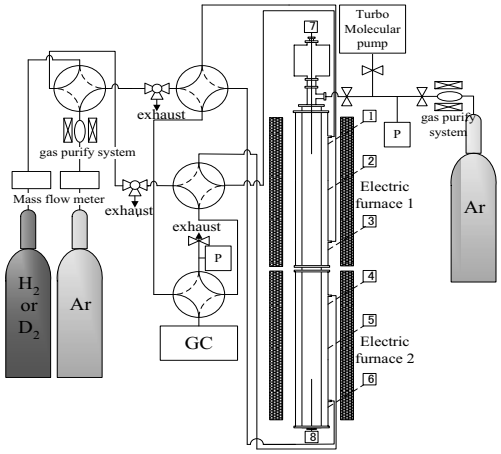

Fig. 2 Experimental arrangement of H permeation with LiPb thermal convection

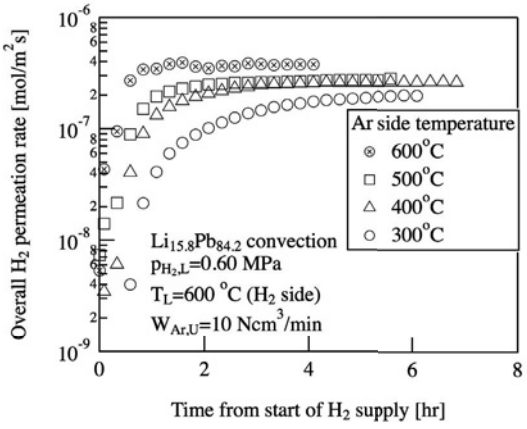

Fig. 3 Transient rates of H permeation through LiPb from lower region to upper region