§49. Simultaneous Recovery of Tritium and Heat from Li-Pb Wet Wall of Laser Fusion Reactor

Fukada, S., Kinjyo, M., Katayama, K., Nishikawa, T. (Kyushu Univ.), Norimatsu, T. (Osaka Univ.), Sagara, A., Yagi, J.

In a laser fusion reactor, Koyo-fast, wet wall concept is proposed in order to avoid strong neutron and gamma irradiation to vacuum chamber walls and to keep moderate temperature during D-T burning. Liquid breeder or coolant flows as a wet wall from the top of the vacuum chamber to the bottom. Neutron reacts with Li-Pb flow after strong Laser shot on a solid D-T pellet. The vapor of Li-Pb and generated He along with unburned D and T are evacuated at 300-500ºC from the chamber, is sent to a vacuum pump system and then gas purification system for separating D and T.

$Li_{17}Pb_{83}$ eutectic alloy has several advantages for the above wet wall materials such as a lower melting point of 235ºC, high TBR, high heat conductivity as a self-cooled breeder and lower vapor pressure. However, liquid metal Li-Pb eutectic alloy has comparatively high chemical activity and can react with oxygen or water even at room temperature. Li-Pb is strictly handled under inert gas atmosphere.

There are three proposed methods of permeation window, gas-liquid direct contact tower and liquid particle dispersion tower. Our experimental results of permeation window were introduced in our previous year report. The largest concern is to develop the most efficient way to recover tritium and heat from breeder flow. In the present study direct contact with Li-Pb-Ar in a bubble tower is experimentally investigated here. $Li_{17}Pb_{83}$ of 3L is melted in a sus304 vessel, and Ar+H_2 gas bubble for H absorption and Ar bubble for H desorption are tested under a constant temperature and gas flow rate. The H_2 content in the exhaust gas is determined by gas chromatography. Before starting H absorption/desorption experiment, relation among bubble diameter, gas flow rate and nozzle diameter and bubble rising velocity in liquid were determined using transparent glass tube and substitution liquid.

Fig. 1 shows examples of time history of the H_2 partial pressure in gas exhausted from Li-Pb, which is initially saturated with a H_2 partial pressure of p_0. The following things are found from experimental observation and analytical calculation:

(1) Diameter of gas bubble formed in Li-Pb and terminal rising velocity are in good agreement with from previous study.
(2) Contact surface area between gas bubble and Li-Pb can be estimated from the above result.
(3) Reproducible H absorption/desorption process is observed. The three hydrogen transfer processes are found to be present in the gas-liquid direct contact process.
(4) The first process is gas replacement in narrow top open space in the Li-Pb vessel, and the process is easily analyzed using time delay.

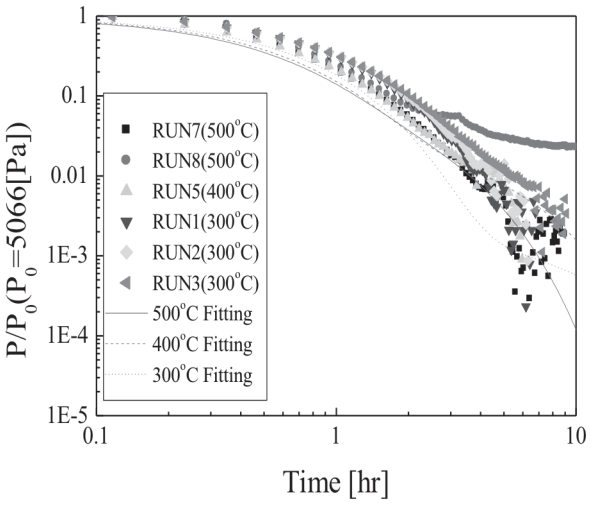

Fig. 1 Hydrogen recovery by gas bubble contact with Li-Pb

(5) The second process is diffusion in a boundary layer formed near bubble surface and the process is correlated in terms of mass-transfer coefficient.
(6) The last is interaction between Li-Pb and wall.

Publishments in FY2015.

(1) R. Yoshimura, S. Fukada, T. Muneoka, M. Kinjo, K. Katayama, "Study on hydrogen isotope behavior in Pb-Li forced convection flow with permeable wall", Fusion Engineering and Design, in contribution, APSOT-1, Mianyang, China, 2015 Nov. 1-5.
(2) T. Muneoka, S. Fukada, R. Yoshimura, K. Katayama, Y. Edao, T. Hayashi, "Experiment on recovery of hydrogen from fluidized $Li_{17}Pb_{83}$ blanket, Fusion Science and Technology, 68 (2015) 443-447.
(3) S. Fukada, T. Muneoka, M. Kinjyo, R. Yoshimura, K. Katayama, "Hydrogen transfer in Pb-Li forced convection flow with permeable wall", Fusion Engineering and Design, 96-97 (2015) 95-100.
(4) S. Yoshimura, R. Yoshimura, M. Okada, S. Fukada, Y. Edao, "Study on hydrogen isotopes permeation in the fluidized state of liquid lithium-lead", Fusion Science and Technology, 67 (2015) 658-661.

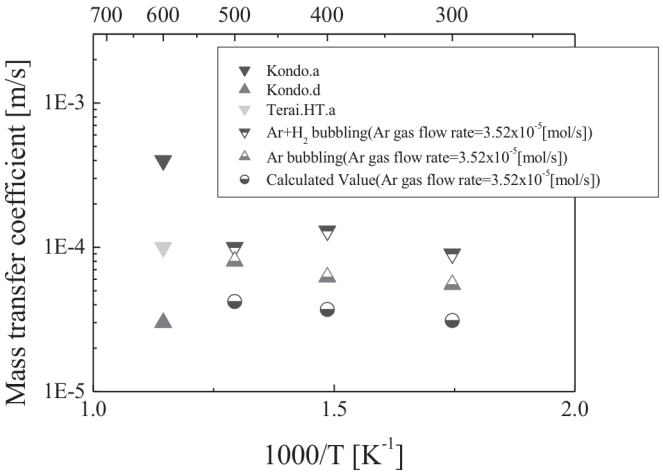

Fig. 2 Mass transfer coefficient of LiPb-gas bubble contact