§8. Gas Absorption and Disorption Behaviors of PbLi

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Liquid eutectic alloy lead-lithium (PbLi) breeder is one of the options of DEMO. The radioactive hydrogen isotope tritium is of special concern and many data are available for the solubility of hydrogen isotopes in the lead-lithium. From the view point of practical use of lead-lithium as blanket, the solubility of other gas which is not generated by neutron reaction in the lead-lithium but involved at both in- and out-pile should be taken into account because the purity control may not be complete in the practical use in huge system. So far, we have little data about the solubility of rare gases in lead-lithium. Feuerstein et al.[1] investigated the transport rate of the rare gases such as He, Ne, Ar, Kr and Xe in lead-lithium. They found that the solubility of helium was found five orders of magnitude lower than that of deuterium, those for Ne, Ar, Kr and Xe even lower than that for helium. In addition, they concluded that argon can be used as cover-gas for a fusion reactor blanket, because the Ar-41 activity will be much smaller than in sodium cooled reactors due to its low solubility in the liquid lead-lithium.

Recently, we have observed the strange phenomena during set-up for the experiment on liquid lead-lithium MHD flow, that is, the pressure of the argon gas which is used as cover-gas was significantly decreased in very leak-tight container and then increased at a later time. The variation of pressure exceeded the retention of argon in lead-lithium which is expected by the published data. Also the similar phenomenon has been observed before the lead-lithium was molten, that is, the lead-lithium was solid. Therefore, we aim to confirm those phenomena under well-controlled condition by using argon, nitrogen and helium.

The experimental rig used for the gas exposure test is shown in Fig.1. The volume of system is 224.9 cm^3. The weight of lead-lithium is 99.5 g (10.5 cm^3) and the volume of test cylinder is 38.5 cm^3 (15.65 mm in inner diameter and 200 mm in height). The leak tester is used to measure the pressure change of the system with resolution of 1 Pa. The temperature calibrator serves both as heater and thermostatic chamber with 0.1 °C accuracy. Argon, nitrogen and helium are used as the exposure gas. The lead-lithium in the test cylinder was exposed to three kinds of gas, argon, nitrogen and helium, at room temperature, 50, 100, 150, 200, 250, 300, 350 °C. The melting point of lithium-lead is 235 °C.

Figures 2 shows the temporal changes of differential pressure between reference portion and work portion filled with argon. Under the conditions below melting point, the absorption of gas in the solid lead-lithium seems to be saturated. From the change of differential pressure, we calculate the amount of absorption of argon gas in the lead-lithium in 2000 seconds and depict it in Fig.3, in which the data for other gases, such as nitrogen and helium are involved. The retention of each gas in lead-lithium is increased with increasing temperature. In the cases of helium and argon, the absorption behavior has peak at 150 °C, the reason will be discussed later. According to the previous studies[1], the transfer rate of argon to lead-lithium is much smaller than that of helium. Of course, the knowledge of diffusion coefficient of argon gas in the lead-lithium is not available, it is impossible to evaluate the solubility. However, the absorption of argon is no less than that of helium. If the above magnitude relation is applicable to the lead-lithium, the problem of argon bubble could be occurred.

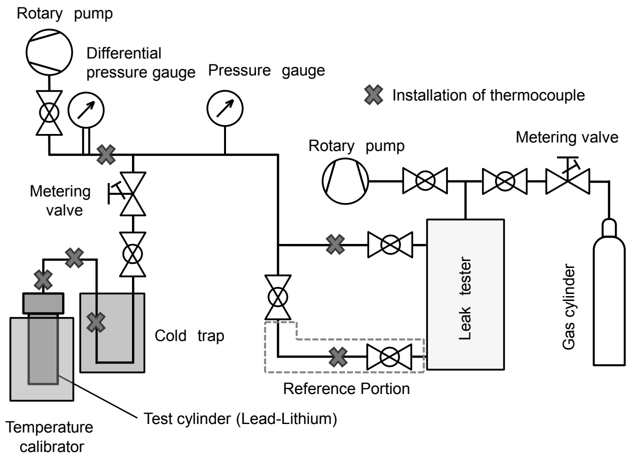

Fig. 1. Experimental rig for gas exposure test.

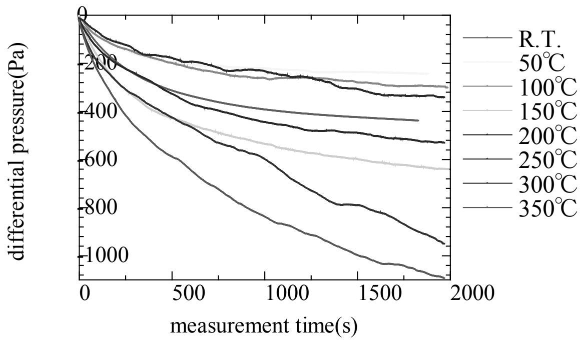

Fig.2. Temporal change of differential pressure of argon gas

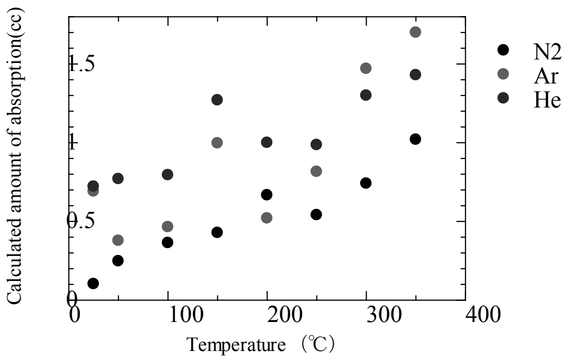

Fig.3. Calculated amount of absorption of gas

1) H. Feuerstein, et al.: Fusion Eng. Des. **14** (1991) 261.