§35. Fundamental Study on Thermofluid Characteristics of Liquid Wall in Laser Fusion Reactor

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To protect from high energy/particle fluxes caused by nuclear fusion reaction to a first wall of a laser-fusion reactor such as the "KOYO" reactor [1], a "cascade type" falling liquid film flow is proposed as a "liquid wall" concept which is one of the reactor chamber cooling and wall protection schemes. In this "cascade-type liquid wall" concept, the first wall of the chamber consists of the saw-shaped wall modules in order to prevent the concentration of the evaporation steam from the liquid surface to the reactor core center.

We have been conducted the proof-of-principle experiments and the numerical simulations to investigate the behavior of the droplets and liquid film on the ceiling wall regarding the wettability effects of the wall surface. It was found that when the liquid film was formed on the wall surface, the liquid never fell away from the ceiling wall of the reactor chamber as long as the vapor was continuously supplied. In addition, the measurements of the liquid-film thickness formed on the inclined wall surface were taken by using the confocal laser scanning microscopy. Since all the previous experiments done by authors were used water as a working fluid, it is necessary whether the condensation behavior of the liquid metal (PbLi) is similar to the water as a simulant coolant or not. Therefore, the fundamental study on thermofluid characteristics of liquid lead-lithium will have to focus on in this study.

During the experiment by using a PbLi loop constructed at UCLA, we found the Argon gas absorption/desorption behaviors. These phenomena never published before, so it should confirm whether these phenomena exist or not. Last year we constructed a preliminary measurement system, but it was not so clear to see these phenomena because the gas leakage was happened during the measurement.

In this year, we have reconstructed the measurement system and ducted the measurement of the Argon gas absorption/desorption behaviors to/from the PbLi ingot. Figure 1 shows the schematic diagram of the measurement system. All system was made of the stainless steel and the leak-tight fittings were used. The absorption of Ar gas can be measured by a leak tester (① in Fig.1). PbLi was installed in the pipe of 3/4 inch in diameter and its temperature was controlled by the temperature calibrator (④ in Fig.1).

Figure 2 shows the absorption behavior when 99.5g (10.5 cm^3) of PbLi was installed in the test section as an example of the measurement data. In order to avoid the effect of additional gas heating by the temperature calibrator, a "blank test" was conducted at first, and its "blank" differential pressure was subtracted from the measurement data. The wall temperature at the test section was set to room temperature, 50°C, 100°C, 150°C, 200°C, 250°C, 300°C, 350°C and 400°C. The melting temperature PbLi is 235°C. So, PbLi might be melt over 300°C, i.e. PbLi became a liquid phase.

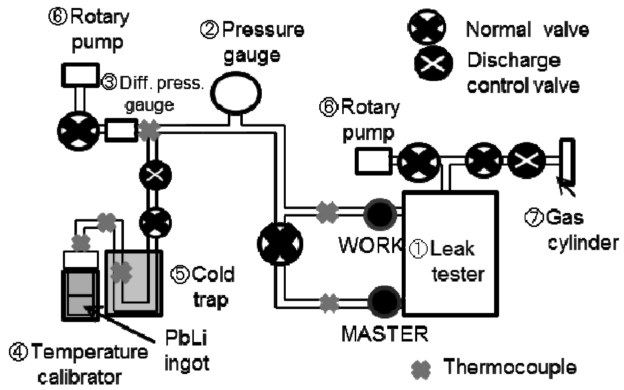

Fig. 1 Schematic diagram of the measurement system

Figure 2 shows the Ar gas absorption behavior into PbLi. The absorption behavior was found in all of the test cases. The amount of absorption and the absorption rate increased with increase of the temperature except the cases of the room temperature and 150°C. As for the case of 400°C, the absorption rate was so fast. It can be considered that the PbLi was completely melting.

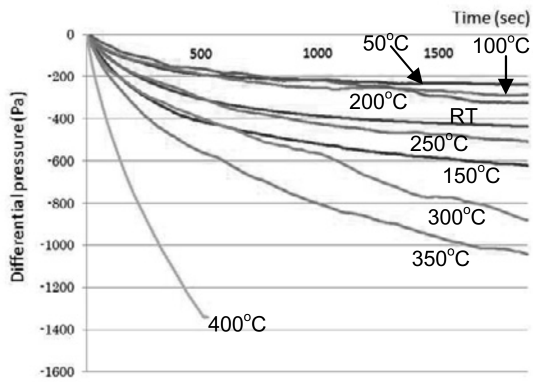

Fig. 2 Ar gas absorption behavior into PbLi

It can be considered that this absorption phenomenon might be caused by the lattice movement due to the Lithium atoms, i.e., PbLi might be a kind of an interstitial solid solution. At present, the Ar-gas desorption experiments have been conducting. According to the preliminary results, the desorption process was also observed.

We should focus on this new phenomenon and would like to be clear what the mechanism of this phenomenon is.

1) Kozaki, Y., et al.: Proc. 7th Int. Conf. on Emerging Nuclear Energy Systems (1993) 76