§5. Construction and First Operation of Gas Pressure Driving Loop for Liquid Breeding Materials

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Fusion material researches for liquid breeding materials, such as hydrogen recovery process, corrosion of structure materials, and function of ceramic coatings have been widely performed so far. However experiments performed in the enough flowing condition with the temperature difference in the system -they are appreciated from a practical point of view- are very few because experimental system which can achieve the condition is usually very large and expensive.

In this this study, we fabricated a new small liquid loop driven by a static gas pressure difference whose schematic is shown in Fig.1 Using water and molten salt FLiNaK as the fluid, circulating tests (bypassing "Test section" and "Heat exchanger" which will be completed in the next fiscal year) were performed in this fiscal year. In case of FLiNaK, the operating temperature was above 800K.

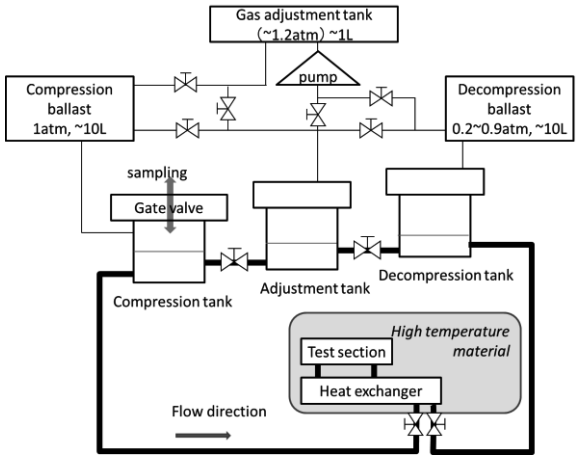

Fig. 1. Schematic of the loop system.

The water flowing experiment at room temperature, pressure difference of 20 kPa was applied to achieve 2 cc/s of flow rate. It was shown that the system worked as designed, while a position of one pressure gauge and control program were found to need revision.

Flowing experiment with molten salt FLiNaK was followed to the attachment of heater components, sheathed thermos-couples and thermal insulator (Fig. 2). FLiNaK salt was prepared from raw fluoride salt (LiF, NaF and KF), whose compositions were 46.5, 11.5, 42 mol % respectively. The raw salt was evacuated and dried at around 600 K followed by the melting and mixing at 800 K. Appling the pressure difference in the system (50 kPa to achieve 2 cc/s of flow rate) and heating the bypass channel correspond to the test section and heat exchanger, FLiNaK was successfully circulated. Liquid circulation enhanced the temperature uniformity through the loop as shown in Fig. 3. Temperature spikes in Fig.3 (one per 2 minutes) is corresponds to the gas pressure control frequency.

In addition to the experiments, applicability of this system as a back-up pump in molten salt cooling fusion reactor was simply discussed. Supposing the required flow rate and pumping pressure as 0.22 m^3/s and 0.1 MPa, pump system (three tanks are stacked directly to be 3 m-diameter and 3 m-height) requires 10m^3 per one minute and only a small amount of electricity to operate solenoid valves. It is concluded that this system can be a candidate back-up pump.

These results have been presented in the conference [1]. Upgrading of the pneumatic valve for high temperature operation, completion of "Test section" and "Heat exchanger", start of the corrosion experiment, and applying for the lead-lithium liquid metal will be done in FY2015.

1) J. Yagi et at.: 2015 Spring Meeting, Atomic Energy Society of Japan, (2015)

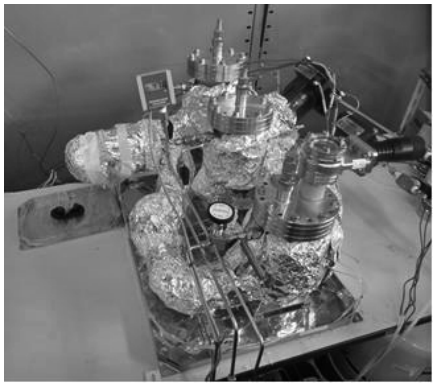

Fig. 2. View of the loop.
(Gas and heater control systems are not included)

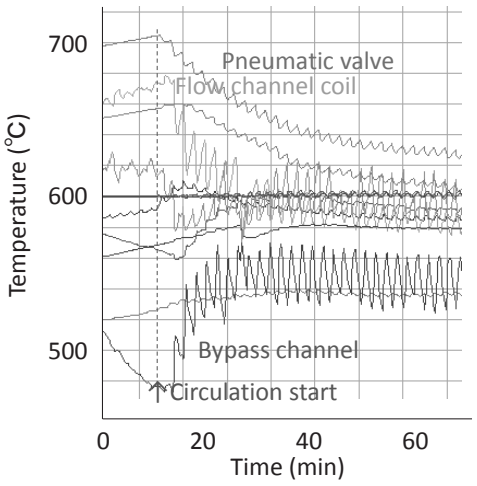

Fig. 3. Temperature transient by the start of flowing.