§6. Design and Construction of Gas Pressure Driving Loop for Liquid Breeding Materials

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Fusion material researches related to 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 an enough flowing condition with a temperature difference in the system, they are appreciated from a practical point of view, are very few because such experimental system is usually very large and expensive.

In this fiscal year, we designed and fabricated a new small liquid loop driven by a gas pressure difference whose schematic is shown in Fig.1. Three tanks for liquid are connected via valves, whose cover gas pressures are 1atm (compression tank), decompressed to be 0.2~0.9atm (decompression tank), and controlled to be equal to that of other 2 chambers alternatively (adjustment tank). Driven by the cover gas pressure difference, continuous flow is generated from the compression tank to the decompression tank. The valve between tanks is opened only when the both tanks have the same cover gas pressure, transporting fluid from the decompression tank to the adjustment tank and from adjustment tank to compression tank due to the level difference.

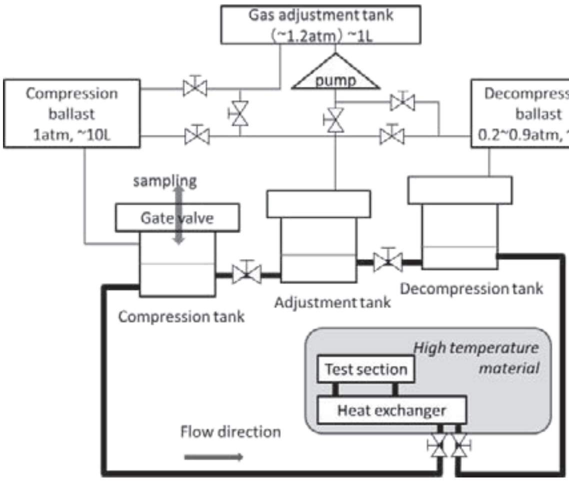

Fig. 1. Schematic of the loop system.

The main flowing path, from compression tank to decompression tank, is made of 1/8 inch SUS316L tube (I.D. 1.755mm) and the length is adjusted to have an appropriate pressure drop as shown in Table I. In this system, fast flow velocity is achievable though flow volume is limited. Moreover, supplying atmospheric pressure to the compression tank enables samples (as well as fluid) to be sampled out through a gate valve on the top of the tank, where a portable glove box is to be connected.

The test section is connected to the main flow path through a heat exchanger (and additional heating) unit, to increase the fluid temperature and to make temperature difference in the loop. Required heat to make the temperature difference is also calculated as Table I, while actual heater power requirement will be decreased below 2~300W by a heat exchanger, whose conceptual design was also completed in FY2013. The test section and the heat exchanger unit is to be made of ferritic steel (for Li and Li-Pb) or Ni alloy (for FLiNaK) considering the compatibility at high temperature.

Construction of the major part of the loop was completed as shown in Fig.2. Flowing test with water, fabrication of the heat exchanger unit will be completed in FY 2014 followed by the campaign using the actual liquid breeding material.

Table I. Summary of the pumping and heating parameter

Fluid		Li	Flinak	LiPb	water
I.D.	mm	1.755			
Length	m	2		1.5	2
Flow rate		2 cc/s (0.83 m/s)			
Pressure drop	kPa	8.6	52	82	15
Liquid head	m	1.75	2.6	0.84	1.6
Tank temperature	K	500	750	550	RT
Temperature difference	K	300	200	300	-
Required heat	W	1260	1520	1140	-

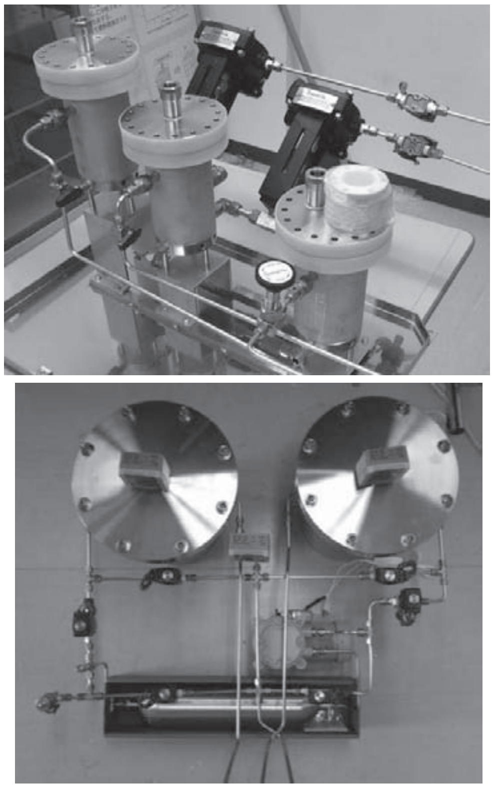

Fig. 2. View of the liquid tanks with pneumatic valves (upper) and the gas control system (lower)