Development of a Liquid Breeder Loop for ITER TBM

Jae Sung Yoon*, Dong-Won Lee, Young-Duk Bae, Suk-Kwon Kim
Nuclear Fusion Engineering Division, Korea Atomic Energy Research Institute,
Yuseong-gu, Daejeon 305-353, Republic of Korea
**Corresponding author: jsyoon2@kaeri.re.kr*

1. Introduction

Korea proposes two DEMO relevant blanket concepts for testing in International Thermonuclear Experimental Reactor (ITER). One is the Helium Cooled Solid Breeder (HCSB) blanket and the other is the He Cooled Molten Lithium/FS(HCML) blanket. KAERI is developing the HCML Test Blanket Module (TBM). The HCML blanket uses He as a coolant at an inlet temperature of 300 ℃ and an outlet temperature up to 443 ℃ and Li is used as a tritium breeder [1]. The Experimental loop for Liquid Breeder (ELLI) is being constructed. The main purposes of the experimental loop are to test effect of magneto-hydro-dynamics (MHD) by a magnet field, verify corrosion by a liquid breeder, and confirm the instruments which are used in high temperature environment. As the breeding material in ELLI, Pb-15.7Li, where Li is 15.7 at %, hereafter called PbLi, will be used. The main components for the ELLI were fabricated and experimental loop for testing is being constructed.

2. Main Components of the ELLI

The main components of the ELLI composed of a sump tank, an electromagnet pump (EMP) and a magnet. The sump tank were equipped with two set of heating line for melting the solid PbLi breeder, thermocouples for measuring temperatures of gas and liquid breeder, a pressure gauge, and a level sensor for detection the level of liquid breeder. A magnet, DC power rate of 150A and 80V, was fabricated and it has water cooling line. The fabricated magnet is shown in Fig. 1.

Fig. 1. A fabricated magnet.

The magnetic field was measured with a gauss meter. The measured value was varied from 0 to 2.2 Tesla by varying current. The measured magnetic field is shown in Fig. 2. The result was shown that the magnetic field was saturated over 100A current rate.

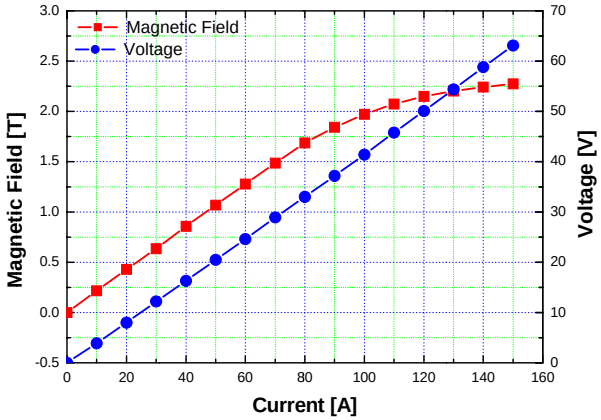

Fig. 2. Measured magnetic field with a gauss meter.

An electromagnetic (EM) pump is used to circulate a liquid PbLi breeder in the experimental loop [2]. The fabricated EM pump has characteristic of the maximum flow rate of 60 liter per minute (lpm). The fabricated EM pump is shown in Fig. 3.

Fig. 3. A fabricated EM pump.

3. Construction of the Liquid Breeder loop

The Experimental Loop for Liquid Breeder (ELLI) is being constructed to test the magneto-hydro-dynamics (MHD) effect in the magnetic field circumstances and

to verify corrosion by a liquid breeder. The ELLI is constructing on the base board which can be tilted about 15 degree. By tilting the base board, the liquid breeder in the loop can flow into the sump tank for reserving during shot down period. A flow meter, pressure gauges, differential pressure gauge and thermocouples were equipped in the liquid breeder loop for the diagnostics. To heat up the loop and sump tank, heat jackets were installed on those and the heat jackets has ability to raise the temperature up to the 550 ℃. The picture of the ELLI is shown in Fig. 4.

Fig. 4. Experimental loop of the PbLi liquid breeder.

4. Conclusions

The Experimental loop for Liquid Breeder is being constructed, and an EM pump, a magnet and diagnostics were installed in the loop. Controllers for an EM pump, a magnet and heaters for loop and sump tank were fabricated and are being testing.

References

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[2] Hee Reyong Kim, Jae Eun Cha, Jong Man Kim, Ho Yoon Nam, Byung Ho Kim, DC magnetic field effect on a liquid sodium channel flow, Nuclear Engineering and Design, Vol. 238, p.280, 2008.