Development Status of the Helium Circulator for the HCS of HCCR-TBS

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1. Introduction

HCCR (Helium Cooled Ceramic Reflector) TBM (Test Blanket Module) was proposed to test tritium breeding technology in the ITER machine. The HCCR TBM will be cooled down by HCS (Helium Cooling System), supply high pressure (8 MPa) and temperature (300 ℃) helium coolant with 1.15 kg/s of mass flow for nominal operation [1].

The real-scale helium circulator, which is main component of the HCS, has been developed since 2014 [2]. In present study, design and manufacture progress of the helium circulator and its verification test plan are described.

2. Design of the Circulator

One of the important design requirements of the circulator is extremely high leak tightness because of the tritium, might be contended very small amount in helium coolant during ITER machine operation. The compressor part and motor part are mechanically separated and a rotational momentum, driven by motor, is transfer from the shaft to the impeller by the magnetic coupling device. Fig. 1 shows the inside structure of the circulator with 3-D modeling and design parameters and technical specifications of the circulator are summarized in Table 1.

The calculated eddy current loss on the stainless steel sealing cap of the magnetic coupling device is very high. To solve the eddy current loss problem of the sealing cap, a glass fiber composite, non-conductive and high strength material, is adapted as a material of the sealing cap. The developed sealing cap was hydraulic pressure tested up to 170 bar. Fig 2 shows the glass fiber composite sealing cap and hydraulic pressure test results.

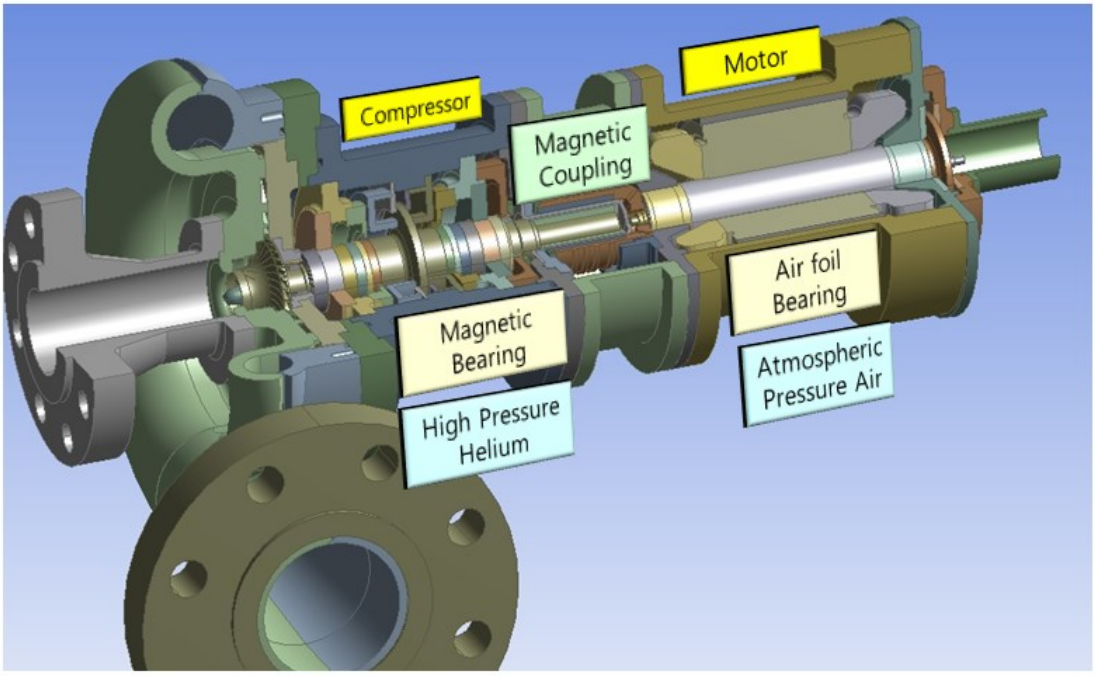

Fig. 1. 3D modeling of the helium circulator

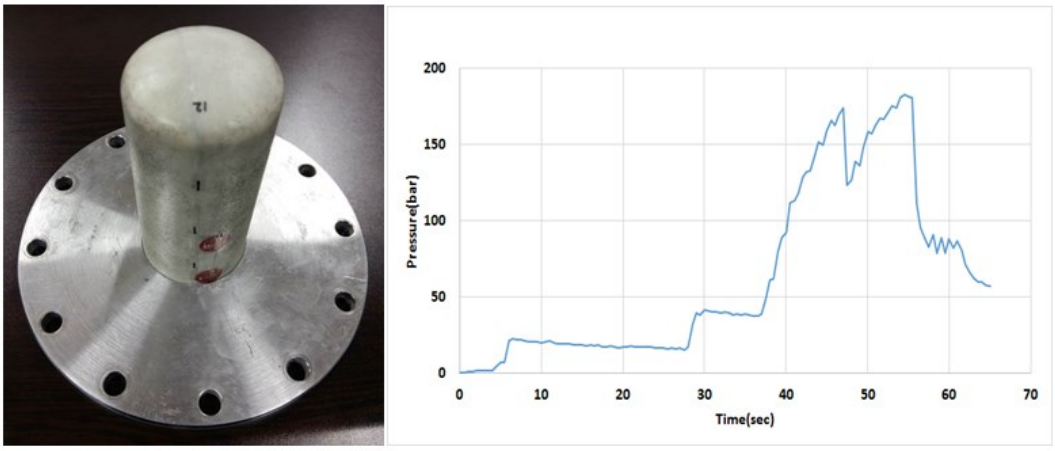

Fig. 2. Magnetic coupling sealing cap made of glass fiber composite and hydraulic pressure test result

Table 1. Specifications of the circulator

Bearing type	Compressor part	Magnetic bearing
	Motor part	Air foil bearing
Impeller and shaft connection type	Magnetic coupling	
Operation (design) conditions	50 (100) ℃ @ at inlet / 8.0 (10.0) MPa /	
Flow capacity	1.5 kg/s of pressurized helium (8 MPa)	
Pressure ratio	1.1	
Overall performance	73 %	
Mechanical speed	70,000 RPM	
Overall power consumption	Less than 120 kWe	
Power supply	380 V, AC 3-phases	

3. Manufacturing and Verification Test Plan

In present, most parts of the circulator have been manufactured and will be assembled by April 2016 and the finished circulator will be tested to verify the circulator and to obtain performance curve in the verification test facility [Fig. 3, ref.3-4]. The verify test and the performance test will be done by May 2016 and then it will be installed in the HeSS facility, verification test loop for the HCS of HCCR TBS, at KAERI [3].

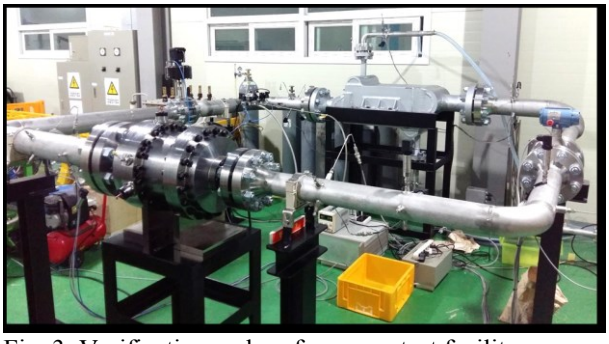

Fig. 3. Verification and performance test facility

4. Conclusions

The real-scale circulator has been developed to provide high temperature and pressure of helium flow as a coolant of the HCCR TBM. To prevent helium leakage, magnetic coupling design was adapted between the shaft and the impeller.

In present, the circulator is under assembled and the finished circulator will be presented by April 2016. The verification and performance test will be done by May 2016 and it will be installed in the HeSS facility.

Acknowledgment

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