

Maintenance issues on HeSS and the circulator performance test plan

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1. Introduction

HeSS (Helium Supply System) was constructed at KAERI to verify a helium cooling system design for a test blanket module for ITER [1]. Main design feature of this test facility is to supply high temperature (up to 300 °C) and high pressure (up to 8 MPa) of helium coolant flow (up to 1.5 kg/s) to a TBM (Test Blanket Module) first wall mockup. The helium circulator and the PCHE (printed circuit heat exchanger) type recuperator are key components of HeSS and performance tests were performed on these components in 2020 [2]. To obtain more test data and to understand performance characteristics of the components, further performance tests have been planned. In this paper, current progress of HeSS maintenance works and the circulator performance test plan are presented.

2. Status of HeSS construction and operation

Development of the helium circulator, which is the most important component in HeSS, was started in 2014 and completed with several improvements in 2019. In the same year, HeSS construction was completed and its trial tests were performed successfully [1]. The following year, to verify design characteristics of the helium circulator and the PCHE type recuperator, the components tests were performed.

For the circulator tests, inlet / outlet pressures and temperatures of the circulator were measured with various test conditions to obtain ‘pressure ratio’ and ‘efficiency’ data of the circulator. The measured pressure ratios were well agreed with the design values but the efficiency values did not match with the design one. Further tests by measuring the exact power directly applied to the circulator are necessary.

For the recuperator tests, the hot and cold side effectiveness were measured as 0.928 and 0.989, respectively. Even if heat loss out of the recuperator during tests was not considered, it is questionable that the hot and cold side effectiveness differ in thermal equilibrium condition. Therefore, additional tests are needed to examine this results in more detail [2].

3. HeSS maintenance for further tests

HeSS modification and maintenance have been carried out. The secondary coolant pipes were modified with flexible hoses and the primary pipe supports were reinforced in order to keep the integrity of the Coriolis

type flow meters from the vibration of secondary water coolant pipes. Instruments were modified and calibrated to obtain absolute pressure at circulator inlet and to control flow rate more precisely, and so to measure flow rates robustly. The components and pipes of HeSS were re-assembled to minimize helium leak in compliance with ASME PCC-1 code with a hydraulic torque wrench.

However, a serious leak was identified on the recuperator during leak test as shown in Fig. 1. The recuperator was inspected by the manufacturer (Alfa Laval CorHex) and serious damage on the diffusion bonded core was identified as shown in Fig. 1 on the bottom. It is concluded impossible to repair the recuperator, so it should be replaced by new one.



Fig. 1. Photos of the serious leak on the recuperator (on top) and inspection results of the recuperator core (on bottom)

3. Summary and future plans

HeSS modification and maintenance were performed for the additional component tests. The planned improvements and maintenance works were successfully done, but damage on the recuperator was identified. It is inevitable to delay the test schedule for several months. To make up for the delayed test schedule as much as possible, a closed circuit composed of the circulator, the control valves, and necessary measuring instruments in the HeSS is built by blocking the open pipes and components with blind flanges and the additional performance test for the circulator will be done by this year.

REFERENCES

- [1] E. H. Lee et al., Current status and commissioning tests of the HeSS experimental facility, Transactions of the KNS Virtual Spring Meeting, 2020.
- [2] E. H. Lee et al., Performance test and modeling with GAMMA-FR of helium circulator and recuperator for helium cooled breeding blanket, FED (166) 112299, 2021.