Developing Fabrication Procedure and Welding Performance test using Developing RAFM steel for ITER HCCR TBM

J. S. Yoon [a*], E. H. Lee [a], S. K. Kim [a], D. W. Lee [a], K. I. Shin [a], H. G. Jin[a], and S. Cho [b]
[a]*Korea Atomic Energy Research Institute, Republic of Korea*
[b]*National Fusion Research Institute, Republic of Korea*
[*]*Corresponding author: jsyoon2@kaeri.re.kr*

1. Introduction

One of the main engineering performance goals of the ITER is to test and validate the design concepts of the tritium breeding blankets relevant to a power producing reactor. The tests will focus on modules including a demonstration of the breeding capability that will lead to a tritium self sufficiency and extraction of heat suitable for electricity generation. Korea has developed two Test Blanket Modules (TBMs) for participating the ITER TBM program; a Helium Cooled Solid Breeder (HCSB) TBM and a Helium Cooled Molten Lithium (HCML) TBM, respectively [1-3]. Recently, solid-type TBM, HCSB was decided to be tested in the ITER, and the name was changed to a Helium Cooled Ceramic Reflector (HCCR) considering the unique concept of using the graphite reflector.

In the present study, the fabrication procedure and welding method of the KO HCCR TBM were introduced. A series of test specimens for a welding performance test and a small box with a cooling channel were designed and readied for fabrication to confirm the welding performance using developing Reduced Activation Ferritic Martensitic (RAFM) steel.

2. Fabrication of a sub-module mock-up using acryl

Korea has developed two Test Blanket Modules (TBMs) for participating the ITER TBM program; a Helium Cooled Solid Breeder (HCSB) TBM and a Helium Cooled Molten Lithium (HCML) TBM, respectively. Recently, a solid type TBM HCSB was decided to be tested in the ITER, and the name was changed to a Helium Cooled Ceramic Reflector (HCCR) considering the unique concept of using the graphite reflector. The newly designed HCCR TBM has four sub-modules and a sub-module is a box with a rectangular structure with a faceted first wall (FW). The front surface of the sub-module is 231 mm in width and 835 mm in height. In the FW of the sub-module, there is a rectangular shape of 11 cooling channels 15 mm in width and 11 mm in height. The conceptual design and basic dimension of the KO TBM is shown in Fig. 1. A sub-module TBM mock-up was fabricated using an acryl plate to verify the manufacturing method of the ITER KO HCCR TBM. The sub-module mock-up consists of the FW, side wall (SW) and breeding zone (BZ). The acryl sub-module was fabricated to the same size of the real one. It was fabricated by assembling each plate of the BZ, SW, and FW. A photo of the fabricated acryl mock-up of a sub-module is shown in Fig. 2.

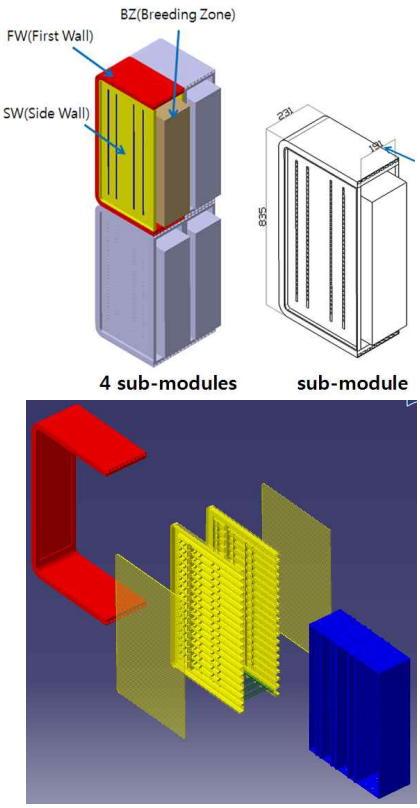

Fig. 1 Concept of KO HCCR TBM and its sub-module dimensions.

Fig. 2 Photo of an acryl mock-up of the TBM sub-module.

3. Welding performance test and developing manufacturing process for HCCR TBM

To verify the welding performance of RAFM steel for TIG welding and E-beam welding, a series of tensile, face bending, root bending and V-notch impact tests will be carried out. The test specimens of the welding test were designed and readied for fabrication using developing RAFM steel. A diagram of the test specimens is shown in Fig. 3. A small BZ mock-up was designed to verify the welding process and welding performance. The BZ mock-up will be fabricated with under developing RAFM steel to verify the welding performance of the RAFM steel and the fabrication process of the breeding box. The height of the mock-up is 240 mm, and its width and length are 191 mm and 240 mm, respectively. A cooling plate is inserted between the side plates and it has 12 cooling channels of 8 mm in diameter. A schematic diagram of the small breeding zone mock-up is shown in Fig. 4.

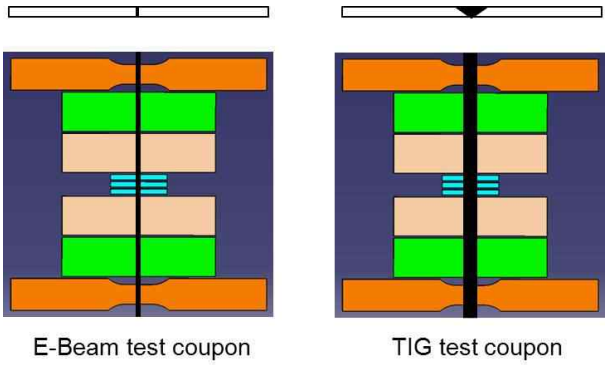

Fig. 3 Schematic diagrams of test specimens for welding performance.

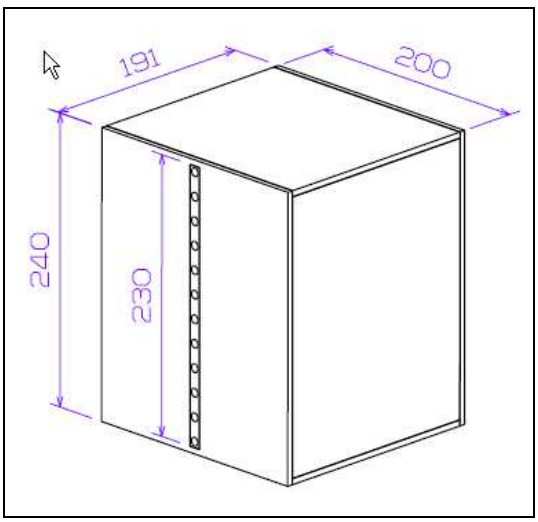

Fig. 4 Schematic diagram of a small breeding zone mock-up.

4. Conclusions

A sub-module TBM using acryl plate was fabricated to develop a fabrication procedure of the sub-module. Each component were fabricated and assembled to check the fabrication procedure of the sub-module. A sub-module will be fabricated with the verified fabrication procedure using developing RAFM steel. To check welding performance of the RAFM steel, a small breeding zone mock-up was designed and readied for fabrication.

REFERENCES

[1] B. G. HONG, D. W. LEE, S. J. WANG, Y. H. KIM, W. K. IN, K. H. YOON, Basic concepts of DEMO and a design of a helium cooled molten lithium blanket for testing in ITER, Fusion Eng. Des. Vol.82, p.2399, 2007.
[2] D. W. LEE, B. G. HONG, K. W. SONG, Y. H. KIM, G. N. SONG, W. G. IN, K. H. YOON, Current status and R&D plan on ITER TBMs of Korea, J. of Korean Phys. Soc. Vol.49, S340, 2006.
[3] D. W. LEE, B. G. HONG, Y. H. KIM, W. K. IN, K. H. YOON, Preliminary design of a helium cooled molten lithium test blanket module for the ITER test in Korea, Fusion Eng. Des. Vol.82, p.381, 2007.