Investigation of Fabrication Procedures and Methods for the HCCP TBM Breeder Units

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1. Introduction

Korea has been developing a helium-cooled ceramic pebble (HCCP) propagation blanket for the Korean nuclear fusion demonstration reactor and fusion reactor development [1]. As a part of this effort, Korea is collaborating with Europe to develop an HCCP test blanket module (TBM) to be installed and tested at ITER. Reduced Activated Ferritic/Martensitic (RAFM) steel is one of the structural material candidates for fusion reactors, and several types of RAFM steel, including EUROFER [2] and F82H [3], have been developed by countries conducting fusion reactor research. In Korea, a type of RAFM steel called ARAA (Advanced Reduced Activation Alloy) has been developed for parts of nuclear fusion reactors, including ITER's HCCP TBM [4-7].

The shape of the HCCP TBM is divided into a TBM box and a TBM shield structure. The HCCP TBM-box is made of RAFM steel, specifically EUROFER-97, and the HCCP TBM shield is made of SS316L(N)-IG. The production of HCCP TBMs for ITER is being divided between Korea and Europe. Korea is responsible for manufacturing the TBM box internal elements (Breeder Units) and TBM shields, while Europe is responsible for manufacturing the TBM box envelope and TBM manifold structure. The final assembly will be carried out by Europe. The structure and geometry of the HCCP TBM are shown in Fig. 1.

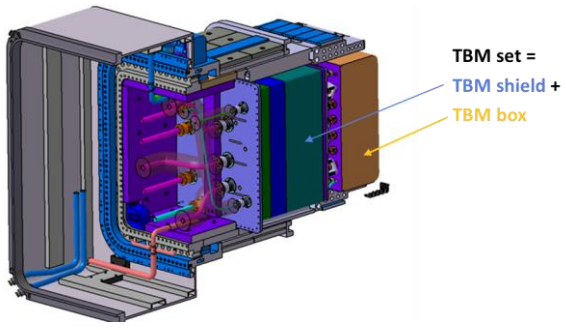

Fig. 1. HCCP TBM geometry diagram

2. HCCP TBM Breeder Units Fabrication Procedures and Methods

The design of the HCCP TBM was carried out by Europe, and the manufacturing based on the designed materials was agreed to be a joint effort between Korea and Europe. In the production of the HCCP TBM, Korea is responsible for producing the TBM box internal elements (Breeder Units) and TBM shields. Confirming the production procedure and methods is essential for TBM production. This study aims to verify the design of the breeder units in Korea and to confirm the production process and methods. The HCCP TBM Breeder Unit consists of 32 U-shaped cooling plates, and the assembly structure of the breeder unit consists of 16 sets of two cooling plates each. Figure 2 illustrates the cooling plate geometry and the assembled breeder unit geometry.

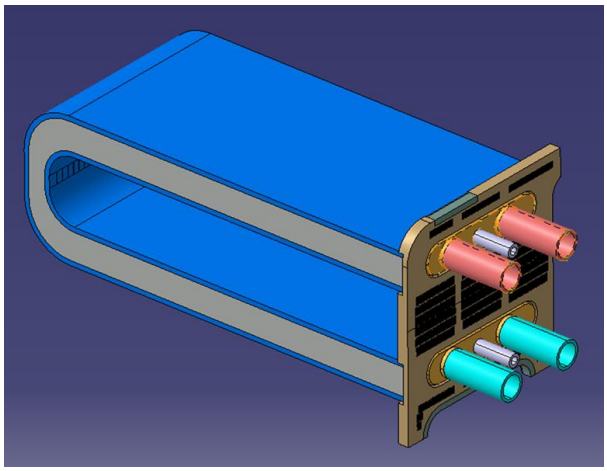

Fig. 2. Schematic of HCCP TBM Breeder Unit

3. Conclusions

The HCCP TBM is a collaborative effort between Korea and Europe, with Korea handling the TBM box internal elements (Breeder Units) and TBM shields. During the manufacturing process, design analysis is essential, and the selection of manufacturing procedures, welding and fabrication procedures, and joining methods holds significant importance. This study begins

with an analysis of the design and subsequently establishes the production procedures and methods.

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REFERENCES

[1] S. Cho et al., Overview of helium cooled ceramic reflector test blanket module development in Korea, Fusion Engineering and Design 88 (2013) 621–625.
[2] B. van der Schaaf et al., The development of EUROFER reduced activation steel, Fusion Engineering and Design 69 (2003) 197–203.
[3] Y. Kohno et al., Irradiation response of a reduced activation Fe-8Cr-2W martensitic steel (F82H) after FFTF irradiation, Journal of Nuclear Materials 191–194 (1992) 868–873.
[4] J.S. Yoon et al., Development of fabrication procedure for Korean HCCR TBM, Fusion Engineering and Design 89 (2014) 1081–1085
[5] J.S. Yoon et al., Fabrication of a 1/6-scale mock-up for the Korea TBM first wall in ITER, Fusion Science and Technology 62 (2012) 29–33.
[6] J.S. Yoon et al., Evaluation of ARAA steel E-beam welding characteristics for the fabrication of KO HCCR TBM, Fusion Engineering and Des.109-111 (2016) 82-87.
[7] Y. B. Chun et al., Development of Zr-containing advanced reduced-activation alloy (ARAA) as structural material for fusion reactors, Fusion Engineering and Design 109-111 (2016) 629–633.