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R&D Status in Manufacturing and Assembly of Tritium Breeding Blanket Component

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Tritium breeding blanket is the core component in the future fusion power plants, which is responsible for tritium breeding, neutron shielding and heat extraction. In order to realize these functions, the blanket component usually is designed as a box-structure modular made of RAFM steel plates, into which the tritium breeding materials and neutron multiplying materials were filled. To exhaust the nuclear heat in the blanket, a serial of square cooling channels was installed in the RAFM steel plates. At the same time, in order to improve the thermal and particle impact resistance on blanket components, tungsten armor is selected as the plasma-facing material for the first-wall sub-component. Therefore, the manufacturing and the assembly of tritium breeding blanket components involves the forming of internal cooling channels in RAFM steel plates, the joints of tungsten /RAFM steel dissimilar material and the welding of RAFM steel and RAFM steel. On the other hand, preparation techniques of reliable tritium permeation barrier (TPB) on RAFM materials need to be explored to prevent tritium loss in the cooling water. To solve these issues, ASIPP sets up a special engineering research team to carry out the development and research of the manufacturing technology for tritium breeding blanket module.

In this report, we will show some recent research progress in the manufacturing and assembly of blanket module. Firstly, we will outline the manufacturing issues for the sub-components in the CFETR-WCCB module, such as the First Wall (FW), the double-wall tubes (DWT) and the manifold [1, 2]. Then the R&D activities for the machining and fabrication of these sub-components have been carried out. In the following, the assembly welding process of the WCCB modules was proposed, and the technology issues for the full-size module were solved. Finally, the first full-size WCCB module was successfully manufactured in ASIPP [1, 2]. In this processing, we set up a number of large-scale machining, welding device and testing platforms. At the same time, some new bonding technology of Fe-Cr-Al and RAFM steel has been developed to prepare the reliable TPB in the cooling channels [3, 4]. And the first FW mock-up with TPB in the cooling channels has been fabricated. In addition, the 3D printing technology has also been applied in the manufacturing of blanket component, and some result will be provided in this presentation.

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