



Contribution ID: 277

Type: **not specified**

Neutronic assessment of HCCR breeding blanket for DEMO

Monday, 17 September 2018 11:00 (2 hours)

Main goals of breeding blanket development in Korea are to develop and verify the integrated blanket design tools; to develop the core technologies such as blanket materials, blanket cooling, and tritium fuel cycle technologies; and to develop and evaluate fabrication and joining technologies. Several breeding concepts are considered as candidates for the Korean DEMO blanket concept. As a solid breeder concept, helium-cooled ceramic reflector (HCCR) blanket and water-cooled solid breeder blanket (WCSB) are considered. The HCCR blanket adopts the unique graphite reflector concept to reduce the amount of beryllium multiplier with the Li_2TiO_3 breeder, reduced activation ferritic-martensitic steel structural material, and helium coolant. This concept of HCCR blanket is adopted to be tested in ITER as a Test Blanket Module (TBM). Currently, the design and R&D activities for HCCR blanket has been performed in Korea.

In this paper, the design concept of the HCCR breeding blanket system is explored to satisfy the global TBR requirement by a neutronic assessment based on the K-DEMO neutronic analysis model employing vacuum vessel, toroidal field coil, blanket and shield. Firstly, sensitivity studies were performed for a various combination of HCCR blanket breeding layers with fixed blanket thickness. The thicknesses and arrangement of the breeder, multiplier and reflector layers in the HCCR blanket were optimized in the view of tritium breeding ratio. Secondly, the neutron flux distribution inside the blanket was calculated to evaluate the neutron shielding performance of the blanket. Finally, the nuclear heat distribution on the blanket was also estimated to support the cooling system design study.

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Session Classification: P1