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Evaluation of tritium inventory and permeation in water-cooled ceramic breeder blanket for CFETR

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Demonstration of tritium self-sustainability is among the key targets of the China Fusion Engineering Test Reactor (CFETR). The water-cooled ceramic breeder blanket (WCCB) is one of the blanket candidates for CFETR. However, tritium retention and permeation in blanket systems can become a bottleneck for the design and operation of future fusion devices with respect to economic and safety concerns. Hence, first attempts have been made to evaluate tritium inventory and permeation in the WCCB blanket for CFETR by two parallel approaches—the conventional lower dimensional diffusion simulation reported in this paper, and the multi-dimensional calculation based on the Finite Element Method (FEM) reported in a separate paper. In the first approach, a 1D model comprising the first wall and the breeding region is developed for the WCCB blanket, with simplifications to reduce complexity yet maintain desired accuracy. Tritium permeation and retention calculations are carried out using the TMAP code. Both the pulse and steady-state operation modes are simulated. The present simulation takes into account the effect of surface conditions, temperature gradient, and trapping in defects. The results show that the amount of tritium permeated is significantly reduced by using a tungsten armor at the front side of the first wall. Simulation results also indicate that in order to meet the designation criteria for tritium permeation, it is necessary to apply coating technology to blanket coolant channels.

Eligible for student paper award?

No

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