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P4.190 Development of a water-cooled blanket concept with pressure tightness against in-box-LOCA for Japan's DEMO

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A conceptual design of breeding blanket module with pressure tightness (as 17.2 MPa) against in-box LOCA has been carried out, based on a pressurized water-cooled solid breeder blanket. The cooling water for DEMO is operated at the PWR water conditions of 15.5 MPa and 290 °C-325 °C. Since the pressure loss of the cooling water system was 1.2MPa, the design pressure of the coolant is set to be 17.2 MPa with the margin of 0.5 MPa. In this design, the breeding zone of the module is divided into 0.1-m-squared cells with rib structure and has simple interior for mass production using a mixed bed of Li₂TiO₃ pebbles and Be₁₂Ti ones. In the DEMO blanket concept with pressure tightness, therefore, the self-sufficient production of tritium and a cooling system for power generation are required to sustain any DEMO operation.

In the FEM analysis, a rib with the thickness of 0.015m is needed basically to withstand the design pressure of 17.2 MPa. In the CFD analysis, the outlet coolant temperature and pressure drop are 321 °C and 0.32 MPa for the blanket concept, when the maximum neutron wall load is 1.66MW/m² and the heat wall load due to radiation from the plasma is 0.5MW/m². In addition, the overall TBR \geq 1.05 was required, which achieve the self-sufficient production of tritium to sustain its own operation. It was found that the self-sufficient production of tritium is likely to be satisfied with the blanket radial width thickness of 0.7m or more when the thickness of the rib structure is 0.015m as suggested by a stress analysis on in-box LOCA. Further improvement of TBR is confirmed when deuterated water is used in the primary coolant system for DEMO.

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