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Impact of Brazed Joint Defects on Operability of ITER Divertor Dome Plasma Facing Units

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Abstract. The study presents the results of numerical simulation and experiments of thermal processes in the mock-ups of the ITER divertor dome plasma facing units (PFU). The divertor is a critical component subjected to extreme thermal loads which imposes high requirements on the reliability of its PFUs. The purpose of the study is to assess the impact of the parameters (geometry, size, localization) of defects in the brazed joint of tungsten-copper armour and bronze heat sink under heat loads q_s = 1–6 MW/m^2. The simulation by the finite-element method was performed for the PFU configurations with defects of various shapes and sizes. The results were compared with the experimental data of thermal tests. It was found that an increase in the defect size leads to an increase in the armour temperature: at the maximum defect area (50% of the joint area), the local temperature increases by 55%, and the average temperature by 40% (q_s = 6 MW/m^2). The defect shape (rectangular/triangular) has a minor effect: deviations do not exceed 1.4% for the maximum and 10% for the average values. The longitudinal castellation (electrical discharge machining) of tiles in the model can affect the temperature distribution. The maximum armour surface temperature for all versions did not exceed 1200 °C. At loads ≤ 4 MW/m^2, cooling remains convective, while at the higher loads, local boiling zones occur without transition to a critical heat flux. The comparison between the calculated and experimental results has detected the similarity in the temperature distributions.

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