THERMAL STRESS PREDICTION IN DIVERTOR COOLING FINGER USING THE LOCAL HEAT TRANSFER DISTIBUTION

B. Konļar[1], I. Simonovski[2], M. Draksler[1], P. Norajitra[3]

[1] *Joǵef Stefan Institute, Reactor Engineering Division*
[2] *European Commission, DG-JRC, Institute for Energy*
[3]*Forschungszentrum Karlsruhe, Institute for Material Research III*

Corresponding author: Bostjan.Koncar@ijs.si

Divertor components of the future fusion reactor DEMO should be able to withstand the heat flux loads of at least 10 MW/m^2. The helium-cooled divertor operating at high pressure (10 MPa) and high temperature (634 ^{o}C) of the helium is foreseen as one of the most plausible options for DEMO. In this study the modular divertor design cooled by multiple impinging jets [1] is analysed. To reduce the heat loads, the divertor target plate is build up of numerous cooling fingers consisting of a tungsten tile, which is brazed on the thimble made of tungsten-alloy. High thermal stresses in the divertor structures due to the heat flux loading may endanger the divertorôs integrity and its cooling capability. Accurate numerical predictions of thermal loading and stresses are therefore very valuable to ensure that the design and material constraints are not exceeded.

An approach that combines computational fluid dynamics (CFD) simulations and FEM (Finite Element Method) predictions of structural response is used to simulate thermal stresses in the divertor cooling finger. Local distributions of heat transfer coefficient (HTC) between the helium and inner surface of the thimble are used as a boundary condition for the thermo-mechanical analysis. Thermal stress predictions calculated from the non-homogeneous HTC distribution are compared with the results where averaged HTC values in three representative zones of inner thimble surface are used. The predicted maximum stresses are considerably higher in the case of realistic non-homogeneous HTC boundary condition. The highest thermal stresses in the tile-thimble assembly are obtained on the thimble inner surface, in the region, where the highest thermal gradients due to jet cooling can be observed (see Figure 1).

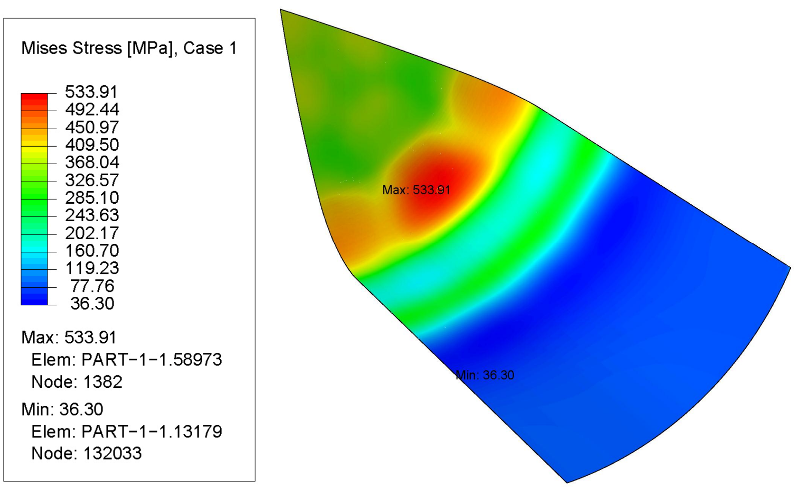

Figure 1: Mises stress distribution on the thimble inner surface

[1] P. Norajitra et al., He-cooled divertor development for DEMO. Fusion Eng. Des., 82, 2007, pp. 2740-2744.