Contribution ID: **177** Type: **not specified**

Sensitivity of First Wall thermal-mechanical performance on cooling channel geometry and thermal conductivity

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

The First Wall (FW) of DEMO or following fusion power reactors will be exposed to high heat fluxes by thermal radiation and energetic particles from the plasma. During steady state, values of over 1 MW/m² are expected for the EU DEMO concept. The function of the FW therefore relies on (1) good thermal conduction from the plasma facing surface through the channel material, and (2) good heat transfer from the channel wall surface into the coolant medium flow. Those aspects influence the shell-average operation temperature of the structural material - determining the materials mechanical strength - and also the temperature spreads within the component - causing thermally induced secondary stresses.

For given boundary conditions, FW designs can be thermal-mechanically optimized. In practice, deviations between the optimum design point versus the device under service have to be accepted due to manufacturing tolerances and variable coolant conditions for variably sized channels. This paper assesses sensitivities of the temperature and stress fields by a parameter study performed by finite element analyses, considering also feedback of the channel geometry to the relative flow ratio through individual channels, using validated correlations for helium thermal-hydraulics.

Further consideration is given to the materials thermal conductivity, which can vary with alloy composition and material history. Thermal conductivities of FW candidate reduced activating ferritic/martensitic steels are reviewed, and own measurements are reported. The possible tolerance in the thermal conductivity due to tolerances in the alloy composition is assessed by application of a neural network trained specifically to the named family of steels.

Acknowledgments: This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 under grant agreement No. 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

Co-authors: ARBEITER, Frederik (KIT); Dr ABOU-SENA, Ali (INR, Karlsruhe Institute of Technology); Dr KULENOVIC, Rudi (Stuttgart, Germany); Dr NEUBERGER, Heiko (KIT, Karlsruhe Institute of Technology); Dr PEET, Mathew (Department of Materials Science and Metallurgy, University of Cambridge); Dr SCHWAB, Florian (INR, Karlsruhe Institute of Technology); Dr VON DER WETH, Axel (INR, Karlsruhe Institute of Technology)

Presenter: ARBEITER, Frederik (KIT)

Session Classification: P1

Track Classification: Plasma Facing Components