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Oral presentation

Optimization and limitations of known DEMO divertor concepts

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Abstract
In this work we will introduce and discuss improvements for two types of DEMO divertors based on known designs: (i) gas cooled designs and (ii) liquid coolant concepts. In a first step, the advantages and disadvantages of gas cooling as well as the necessityof a jet impingement to increase the heat transfer coefficients will be discussed. Further discussion deals with the pros and cons of liquid coolant concepts, like for example, liquid metal or water cooling.
Thereafter, we will present two rather contrary DEMO divertor concepts which are based on today's knowledge on refractory materials science, fabrication and joining technology. The first design is based on the known helium cooling concept using jet impingement. Drawbacks of the actual He-cooled divertor design are small scale parts as well as the necessary high helium inlet temperature of about 800°C which leads to the question: How can we deal with such high helium temperatures? This paper shows a solution for large scale components as well as a new thermal management for the helium outlet gas that we call 'cooling of the coolant'.The second improved concept uses water flowing through steel pipes, typically made of Eurofer steel. It is well known that using Eurofer at low temperatures is critical due to its severe embrittlement under neutron irradiation. Here we will make a proposal how it could be possible to use the Eurofer steel anyway: The solution could consist in a limited operation period followed by an annealing cycle at 550°C for a few hours during any maintenance shut down phases. Finally,a special transition from the steel pipes to the tungsten monoblocks will be described. This is important to reduce the load resulting from the mismatch of the thermal expansion coefficients.
Both concepts are discussed in terms of materials selection due to material limits, joining technology, thermal management, and simulation with a special focus on the material issue using already existing and available materials.