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P2.136 Rationale for the selection of the operating temperature for the DEMO vacuum-vessel

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In magnetically confined fusion devices the plasma operation takes place in a hermetically sealed vacuum vessel (VV) of unconventional size and shape that enables the crucial high-vacuum environment.
Apart from this basic purpose the DEMO VV has to fulfil several additional requirements.
It has to provide support to the in-vessel components (IVCs) in all operational conditions in particular during plasma disruptions. Due to the double-walled construction with large water-cooling channels in the inter-space it is also designed for the removal of the heat generated during plasma operation and in accidental scenarios involving failure of IVC cooling loops. The VV is also the main constituent to the neutron and radiation shielding function protecting other components in particular the superconducting coils and all maintenance areas. Therefore wall irritation and damage by neutrons need to be considered. In addition the usage of the hydrogen isotope tritium as part of the fusion fuel requires the vessel to act as the primary confinement barrier for radiation. Tritium surface retention and bulk permeation contribute significantly to the tritium inventory.

The temperature for conditioning or operation of conventional vacuum chambers is generally chosen to provide excellent vacuum conditions. Due to the additional functions of the DEMO VV the arguments for the temperature selection are multifaceted. E.g. the higher saturation pressure for higher coolant water temperatures and the relative thermal expansion between VV and IVCs must be considered, too. In DEMO also the impact of the VV coolant temperature to the overall plant efficiency is a notable factor.

This paper analyses the topic and provides rationales for choosing a suitable operating temperature for the DEMO vacuum vessel.

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