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P4.171 EU DEMO WCLL BB breeding zone cooling system design: analysis and discussion

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The Water-Cooled Lithium-Lead Breeding Blanket is a candidate option for the European DEMO nuclear fusion reactor. The blanket is a key component in charge of ensuring Tritium self-sufficiency, shielding the Vacuum Vessel and removing the heat generated in the tokamak plasma. The last function is fulfilled by the First Wall and Breeding Zone independent cooling systems.

Several layouts of the Breeding Zone coolant system have been investigated in the last years in order to identify the optimum configuration that guarantee Eurofer temperature below the limit (550°C) and good thermal-hydraulic performances (i.e. water outlet temperature 328 °C). A research activity is conducted to study and to compare three configurations which rely on different arrangement of the stiffening plates (i.e. toroidal-poloidal and radial-poloidal), orientation of the cooling pipes (i.e. horizontal, vertical) and PbLi flow path. The analysis is carried out using a CFD approach, thus a three-dimensional finite volume model of an elementary cell of the outboard segment is developed for each configuration, adopting the commercial ANSYS CFX code. The objective of the activity is to compare the Breeding Zone cooling system layouts, identifying and discussing advantages and key issues from the thermal-hydraulic point of view, also taking into account feedbacks from MHD and neutronics analyses. The research activity aims at laying the groundwork for the finalization of the Water Cooled Lithium Lead blanket design, pointing out relevant thermal-hydraulic aspects.

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