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P3.015 Numerical analyses and tests for optimized and enhanced heat transfer solutions in DEMO

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A set of novel design solutions for high performance cooling systems have been developed and tested by Consorzio RFX, achieving, with experimental tests, the challenging heat transfer conditions foreseen for Heating and Current Drive Systems of present and future nuclear fusion devices.
The project, called Multi-design Innovative Cooling Research & Optimization (MICRO), has the triple objective of:

- Verifying the full qualification of the manufacturing process and assess the cooling performance of the present solutions applied on the accelerating grids designed for ITER Heating Neutral Beam Injectors and MITICA experiment;
- Identifying alternative designs realizable with presently qualified manufacturing processes for improving heat transfer mechanisms with limited pressure drops;
- Developing further optimized solutions by means of the investigation of the interrelated effects of geometric parameters and thermofluid dynamic properties of the coolant fluid.

The main aim of present work is on one hand to extend the fatigue life-cycle of high thermal stress components and to investigate the possibility to employ alternative dielectric fluids with respect to the present project solution (ultrapure water). Such category of fluids is characterized by poorer thermofluid-dynamic properties resulting in a less performing cooling capability. Such drawback is meant to be compensated by the enhancement of the heat transfer mechanisms guaranteed by the novel design solutions.
If the thermo-structural requirements set for such kind of components would be nevertheless satisfied, these dielectric fluids could represent a significantly advantageous option with respect to the existing technologies.

This paper presents in the first part the results obtained from a series of thermofluid-dynamic tests carried out on sub-scaled models of the electrostatic grids, while in the second the outcomes of numerical analyses implementing perfluorinated compounds, instead of water, and the preparation of next experimental tests.

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