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P2.129 Structured Cooling Channels for Intensively Heated Blanket Components

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The cooling performance of surface structuring for enhancing heat transfer in cooling channels of helium-gas cooled First Wall applications and their prospects of success in efficiency and effectiveness were investigated for several thermal-hydraulic conditions and structure designs in the last years. Cooling channel structured by upstream and downstream directed, truncated 60° V-shaped ribs, by semi-detached 60° V-shaped ribs and by spherical dimples were investigated. The structure design was developed under consideration of thermal, mechanical and fabrication aspects. The heat flux density was in the range from 0.5 MW/m2 to 1.0 MW/m2 as expected to occur on the first wall and the helium mass flow rate was varied from 0.023 to 0.070 kg/s. The results can be summarized as follows:

- Based on numerical results, engineering correlations for heat transfer coefficients were evolved and can be used in thermal-mechanical analysis and design of cooling channels.
- An efficiency criterion for evaluating the cooling performance of structured cooling channels shows that the pumping power is significantly reduced for the structured cooling channels to obtain an equivalent cooling performance when compared to smooth cooling channels.
- Lowest friction factors occur for the dimpled channel walls, but V-shaped ribs perform better than spherical dimples due to the enormous heat transfer enhancement.
- Possible fabrication concepts for the surface structures were presented.

It is concluded that surface structuring is a viable approach to make helium cooling of thermally highly loaded plasma facing components feasible, and can also improve the thermal performance of blanket internal cooling.

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