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Numerical study of conjugated heat transfer for DONES high flux test module

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Helium flows at low pressure (0.3 MPa) are used to cool the specimen capsules and the structure of the neutron irradiated High Flux Test Module (HFTM) of the DEMO-Oriented Neutron Source (DONES). The flow path includes inlet and outlet ducts with large cross sections, but also mini-channels with 1 mm gap width, where a high velocity low Reynolds number laminar to turbulent transitional heated flow influences the temperature of the irradiated specimens. The large span of Reynolds numbers from laminar to fully turbulent are a significant challenge for the simulation of the complete HFTM and requires validation of models.
Numerical simulations have been carried out for turbulent (Re = 4500, 6000 and10000) helium flow in a heated mini-channel using the commercial CFD code Star-CCM+ v.12.06. The results were compared with measurements obtained from the IFMIF thermal-hydraulic experiments (ITHEX). Detailed comparisons were made between the k-ϵ, k-ω-SST, and V2F models with different treatment methods of near-wall layer. The appropriated models have been used for the numerical thermo-hydraulic analysis of the conjugated heat transfer the in HFTM. The temperature distribution in the HFTM structure calculated for normal operational conditions serves as a basis for a subsequent thermo-mechanical structure analysis of the HFTM.
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