Experimental test facility for turbulent flow measurements in a rib-roughened channel at Reynolds numbers of Re ≥ 50 000

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Cooling channels with non-circular cross-section and one- or two-sided rib-roughened channel walls are widely used in thermally highly loaded heat exchanger applications. An efficient rib design bases upon detailed insights into the flow and heat transfer phenomena which occur close to the heat transfer surfaces. Due to the difficulties in the simultaneous measurement of velocity and temperature fields, numerical simulations can be helpful in resolving the complex flow mechanisms without experimental limitations. The capability of computational fluid dynamics (CFD) in predicting accurately the turbulent thermal flow fields in structured cooling channels is sensitive to the numerical scheme, turbulence modelling approaches and boundary conditions and, thus, the application of CFD for designing heat transfer surface structures requires a high-quality validation by experimental data. Although turbulent flow and heat transfer in rib-roughened square or rectangular channels were investigated extensively in the past, studies reporting about detailed measured turbulence quantities are rare for the moderate and high Reynolds number flows of thermally highly loaded heat exchanger applications. The present work introduces a new experimental test facility for flow velocity and temperature measurements in rib-roughened channels at Reynolds numbers in the range from $Re_H = 5.0 \times 10^4$ to 2.5×10^5 at the Institute of Neutron Physics and Reactor Technology, Karlsruhe Institute of Technology. Measured flow velocities in a k-type rib-roughened square channel provided high-order statistical moments of the turbulent flow field, which can be used as benchmark data for the validation of CFD.

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