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Characterization of Copper Mesh as a Heat Transfer Matrix at Low Temperatures

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Woven metal mesh is a highly porous material that has a great potential as an internal structure for high-effectiveness compact counter-flow heat exchangers and regenerators due to its large surface area and remarkably high transversal-to-axial conductivity ratio. This paper outlines an experimental characterisation and preliminary investigation into the copper mesh as a heat transfer matrix. Measurements of the thermal conductivity of the mesh in plane (45º to the fibre) and through-plane directions in the 10 K – 290 K temperature range are presented. These data are used to determine the mesh RRR and tortuosity as well as to estimate thermal conductivity in plane at 0º angle to the fibres. The temperature-dependent in- to through-plane conductivity ratio reached values in the range of 1000-10000. The stress-strain profile of a 100-layer mesh stack was measured at 77 K and 290 K to further support the application of the stacked mesh layers. Moreover, the corresponding contact thermal conductance between copper mesh and different wall materials has been studied (copper, bronze, stainless steel) in 10 K – 290 K temperature range. Copper and bronze wall to copper mesh contacts were found to have the largest thermal conductance. Analysis and interpretations of all the obtained results are offered.