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PORTFOLIO

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Temperature distribution on an isoflux surface cooled by an impinging liquid jet with a 40° Wall Jet Swirl Generator

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Contemporary electronic systems generate high component-level heat fluxes (Schmidt 2005). Jet impingement cooling combined with a target surface augmentation is an effective way to induce high heat transfer coefficients in order to meet thermal constraints (Jeffers et al. 2009). The aim of this work is to present the local heat transfer distribution as a result of superimposing a 40° swirl generator in the wall jet region of a confined and submerged impinging water jet. A square-edged 8.5 mm inner diameter round

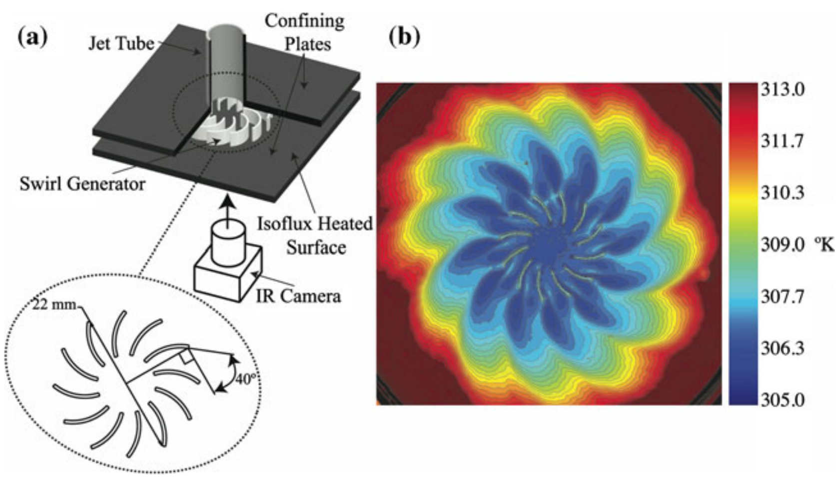

Fig. 1 Isoflux foil heater method used shows the influence of the 40° swirl generator on the local temperature distribution of a submerged and confined impinging water jet issuing at an $Re = 10{,}000$. **a** The experimental setup and **b** local temperature distribution

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nozzle was used to create an impinging jet which was geometrically constrained to a height to jet diameter ratio of 0.5. The swirl generator was positioned directly under the impinging jet, as shown in Fig. 1a. A non-conducting 40° swirl generator was used in order to evaluate the influence of swirl without the additional surface area associated with a conducting surface. The jet impinged onto a 12.5 μm thick stainless steel foil supported by a 100 mm C-Range Hawk-IR infrared transparent sight glass. The stainless steel foil was connected to a DC power supply via two copper bus bars in order to generate a spatially uniform heat flux of 30.3 kW/m^2 within the foil. The local temperature distribution was measured using a FLIR Systems ThermaCAM Merlin infrared camera positioned to view the underside of the stainless steel foil, painted matt black, through the infrared sight glass. Figure 1b shows the temperature distribution of a confined and submerged impinging jet as a result of a 40° swirl generator. Heat transfer coefficient is inversely proportional to temperature and can be calculated using the recorded jet inlet temperature of 303.3 K. The temperature distribution shows a low-value region at the stagnation zone of the impinging jet and the position where the fluid exits the vanes. These low temperature regions coincide with high fluid velocity, and as a result the temperatures increase radially out from the initial impingement as the fluid velocity drops. The understanding of this heat transfer distribution has practical implications for the design of impingement cooling devices.

References

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