Heat transfer and flow field measurements of a pulsating round jet impinging on a flat heated surface

The seminar will be given in Hebrew

Heat transfer by means of impinging jets has been thoroughly investigated due to its strong ability to achieve high heat fluxes from surfaces. Applications include cooling/heating of electronic components, laser diodes, and turbine blades, amongst others. In order to achieve higher heat transfer coefficients, jet pulsation can be applied. However, pulsation may also lead to decreased heat transfer, and for a chosen jet configuration the optimal pulsation frequency and setup needs to be determined.

Applying flow pulsation to an impinging round jet while keeping the average mass flow rate constant, may increase heat transfer compared to a steady impinging jet. Here, heat transfer and flow field characteristics of a pulsating, round jet impinging on a flat heated plate were measured and compared to those of a steady jet. The surface to jet nozzle stand-off distance equaled two nozzle diameters ($D$) and Reynolds numbers based on the average steady jet exit velocity were $Re = 4,606, 8,024$ and $13,513$. Strouhal numbers ranged between $2 \times 10^{-3} < Sr < 15.6 \times 10^{-3}$. Jet exit velocities varied nearly sinusoidal, having a radially uniform exit velocity at each phase. Self-similarity of the mean radial velocity in the wall jet was not attained for the pulsating jet, and the quasi-steady assumption cannot be applied.

Radial distributions of the Nusselt number, $Nu$, showed the well-known secondary peak at $r/D \approx 2$ ($r$ denotes radial distance away from the jet centerline) due to the generation of secondary vortices, while as a result of partial confinement, another peak was detected at $r/D \approx 4$.

Overall heat transfer enhancement, $\Lambda$, of maximum 15.7% and 4% at $Re = 4,606$ and $8,024$, respectively, was obtained within the studied $Sr$ range. At $Re = 13,513$, $\Lambda$ was slightly negative. Additionally, at $Re = 8,024$ a local maximum on $\Lambda$ was obtained at $Sr = 4.1$. The trends of the overall heat transfer enhancement as a function of $Sr$ could be well correlated to the primary vortex generation Strouhal number, $Sr_v$. Our results indicate that heat transfer enhancement is associated with increased $Sr_v$ and attenuation with decreased $Sr_v$, compared to the steady jet.

In conclusion, the seminar will cover the experimental study of heat transfer and flow field characteristics of a pulsating round jet impinging on a flat heated surface, focusing on the effects of pulsation on heat transfer coefficients and flow field behavior.