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Impingement array cooling recent developments: Effects of mach number, reynolds number, temperature ratio, hole spacing, and jet-to-target-plate distance

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Presented are data which illustrate the effects of Mach number, Reynolds number, temperature ratio, hole spacing, and jet-to-target-plate distance on surface Nusselt numbers produced by an array of jets impinging on a flat plate. The local and spatially-averaged Nusselt numbers, and local and spatially-averaged recovery factors are unique because: (i) data are obtained at constant Reynolds number as the Mach number is varied, and at constant Mach number as the Reynolds number is varied, (ii) data are obtained at constant Reynolds number and constant Mach number, as the temperature ratio is varied, (iii) data are obtained at constant temperature ratio, Mach number, and Reynolds number, as the impingement hole spacing is varied, (iv) data are obtained as the jet-to-target-plate distance is changed at constant temperature ratio, Mach number, Reynolds number, and hole spacing, and (v) data are given for jet impingement Mach numbers up to 0.74, and for Reynolds numbers up to 60,000. Also included are crossflow-to-jet mass velocity ratio data and discharge coefficient data. Impingement hole spacings are 5*D*, 8*D*, and 12*D* in the streamwise and spanwise directions, with jet-to-target-plate distances of 1.5*D*, 3.0*D*, 5.0*D*, and 8.0*D*. Local spatially-resolved and spatially-averaged Nusselt numbers generally show strong dependence on the impingement jet Reynolds number as the jet Mach number is maintained constant. Nusselt number data taken at Mach numbers greater than approximately 0.25 (as the Reynolds number is held constant) show that Mach number has a significant impact on local and spatially-averaged Nusselt numbers. This Mach number dependence changes with hole spacing, with greater Nusselt number increases with the less dense impingement arrays.

Biography

Phil Ligrani is currently the Oliver L Parks Endowed Chair, and Professor of Aerospace and Mechanical Engineering at Parks College of Saint Louis University. His previous academic position was as the Donald Schultz Professor of Turbomachinery in the Department of Engineering Science at the University of Oxford. There, from 2006 to 2009, he was also Director of Oxford University's Rolls-Royce UTC (University Technology Centre) in Heat Transfer and Aerodynamics. From 1994 to 2006, he was a Professor of Mechanical Engineering, Adjunct Professor in the Department of Bioengineering, Director of the Convective Heat Transfer Laboratory, and Associate Department Chair in the Department of Mechanical Engineering at the University of Utah.

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