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Coupled Velocity and Cooling Effectiveness Measurements of a Film Cooling Hole With Varied Blowing Rates and Ejection Angles EMIN ISSAKHANIAN, CHRIS J. ELKINS, JOHN K. EATON, Stanford University — Film cooling is used to shield turbine blades from combustion gases which are at temperatures above the melting point of the blade's constituent alloy. Maximizing film cooling effectiveness allows higher combustion temperatures and decreases need for bypass air. The present experiment studies flow through a single film cooling hole jetting into a square channel. The momentum thickness Reynolds number of the main flow is 500. The diameter of the cooling flow is 10 times the momentum thickness at the hole exit. The cooling flow Reynolds number varies between 1250 and 5000. Magnetic Resonance Velocimetry (MRV) and Concentration (MRC) are used to measure mean velocity and coolant concentration of the 3-D field both inside the main channel and inside the cooling hole and feed plenum. By marking only the main flow with a passive scalar, the MRC data allow measurement of cooling flow concentration, which by analogy is related to the temperature of the fluid. The velocity data shows the development of a counter-rotating vortex pair downstream of the jet. These vortices transport cooling flow away from the channel floor resulting in a lifted kidney-shaped coolant cross-section and reduced effectiveness. The varying strength of this flow feature and of surface effectiveness due to different ejection angles and blowing ratios is studied.

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