Film Cooling Performance on Curved Walls with Compound Angle Hole Configuration

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The effects of compound angle injection hole configuration on film cooling phenomena over curved walls were investigated using transient liquid crystal thermography in the current work. Test pieces with straight circular hole and forward-expanded hole configurations, both with streamwise injection angle (γ) of 35°, were used for the film cooling measurement. Two compound angles of 0° and 45° were tested for each hole configuration, and the pitch-to-diameter ratio of holes (P/D) was 3. The strength of curvature ($2r/D$) for the convex test pieces was 92.5, and 86.5 for concave test pieces. All measurements were conducted under the mainstream Reynolds number (Re_d) of 1700, mainstream turbulence intensity (Tu) of 3.8 %, and the density ratio between injection flow and mainstream (ρ_c/ρ_m) was 0.98. In current study, the influences of blowing ratio (M) on film cooling performance of both convex and concave walls were investigated by varying the range of blowing ratio from 0.5 to 2.0. Detailed film cooling effectiveness and heat transfer results have been evaluated. The present measured results show that the injection flow of forward-expanded hole configuration provides better surface protection in most cases. Moreover, compound angle injection flow can produce higher film cooling effectiveness as compared with simple angle injection flow.

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