Numerical Investigation of Film Cooling with Crossing Jets on a Flat Plate

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ABSTRACT

This study employs computational fluid dynamics simulation to investigate the flat-plate film cooling performance with cross-injection coolant jets from double-row holes of different arrangements. The parameters and their values in this study are the following. The distance between the first (upstream) row and the second (downstream) row is 2.5D, 4D, or 5.5D. The separation distance between each pair of holes in the cross stream direction is 0D (Configuration 1), 1.5D (Configuration 2), 3D (Configuration 3), and 4.5D (Configuration 4). The blowing ratios are M = 0.5, 1.0, and 2.0. All the film cooling holes have an inclination angle of 30 ° . The orientation angle is for the first-row holes and for the second-row holes. The standard k- model was used in the computation. Temperature distribution on the flat plate, the local cross-stream averaged film cooling effectiveness, and the temperature distribution in the boundary layer are reported. In addition, the effect of different blowing ratios from these two rows on the cross-injection cooling performance is also investigated. Results show that the cooling performance is the best when the distance between these two rows is 2.5D, followed by 4D. When M = 0.5 and 1, Configuration 2 has the best cooling results, while Configuration 1 performs the best when M = 2. Overall, it is seen from the temperature distribution in the boundary layer that the film effectiveness for low blowing ratios is basically determined by the interaction of individual coolant jet with the main flow. At high blowing ratio, the effect of cross injection from paired holes becomes more important. When the blowing ratio is different from each row, it is more beneficial to have higher blowing ratio at the upstream-row holes. Keywords: simulation, double-row holes, cross injection, boundary layer.

Keywords : Film Cooling

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