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NUMERICAL INVESTIGATION OF INFLUENCE OF BLOWING RATIO ON FILM COOLING OVER A FLAT PLATE WITH BENT INJECTION HOLE

Content :

Present cryogenic rocket engines are subjected to hot gas temperature of the order of 3500K with combustion chamber pressure exceeding 20MPa leading to local wall heat flux densities of more than 100MW/m2 and hence chamber has to be protected by active cooling system. Many rocket engines, gas turbines and combustors employ film cooling to protect hot combustion gas side walls. The present study aims at numerical investigation of effect of blowing ratio on film cooling effectiveness for 30°-hole injection angled straight and bent hole flat plate model. The diameter (D) and length (L) of hole is 6.35mm and 8D, length of the plate surface is 38D and width is 3D. hole injection angle is in stream wise direction of the flat plate. Numerical analysis is conducted at a nominal flow Reynolds number of 4200 based on the injection hole diameter, by varying the blowing ratios in the range of 0.50 to 1.50 at the density ratio of 1.2. This study aims at bringing the optimized mass flux ratio (i.e. blowing ratio) for the two considered different injection hole configurations and the performance of film cooling effectiveness is compared with straight and bent hole configurations. The flat plate models are designed in solid works modelling software, the flow domain is meshed using Ansys ICEM CFD and Ansys fluent is used as solver for the considered numerical simulation. 'O' type grid is selected to mesh the injection hole and structural hexa mesh is considered for the flow field. Laterally averaged, center line and span wise averaged film cooling effectiveness for various blowing ratios are computed for straight hole with 35° injection angle and the computation of numerical results for bent injection hole are under process. It is found that for straight hole with 35° injection angle the film cooling effectiveness increases with increasing in blowing ratio 0.5 to 0.75 further increase in blowing ratio from 0.75 to 1.00, 1.25 and 1.50 it is found decreased gradually. The numerical results are compared with experimental results available from the previous literature and found in good agreement.

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