FILM COOLING OF WAVY AFTER BURNER SECTION OF FIGHTER AIRCRAFT ENGINE

A dissertation submitted in partial fulfillment of requirement for the award of degree of

MASTER OF TECHNOLOGY
IN
THERMAL ENGINEERING

Submitted by
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2010MET2840

Under the guidance of
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Prof M R Ravi

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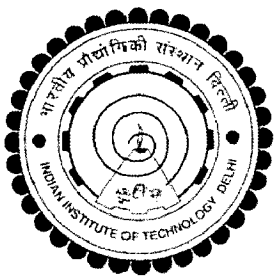

Department of Mechanical Engineering

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CERTIFICATE

This is to certify that the thesis entitled " **FILM COOLING OF WAVY AFTER BURNER SECTION OF FIGHTER AIRCRAFT ENGINE**", being submitted by **Subash S** (2010MET2840), to the Department of Mechanical Engineering, Indian Institute of Technology, Delhi in partial fulfillment of the requirement for the award of the degree of **Master of Technology** in Thermal Engineering, is a bonafide work carried out by him under my guidance and supervision. This work has not been submitted anywhere else for the award of any other degree or diploma.

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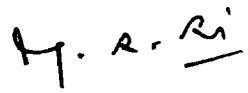

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ABSTRACT

Film cooling is one of the cooling techniques used for surface cooling, in which a thin film of cold air is made to flow over the surface by blowing the coolant through the holes or slots provided on the surface. The thin film of cold air prevents the hot air from coming in direct contact with the surface, thereby reducing the heat transfer to the surface. The corrugated wavy wall of the after burner section of a jet engine is cooled by blowing the bypassed, relatively cool and slightly compressed (by the fan) air through the holes provided on the wavy wall. The position and orientation of holes on the wavy wall should be suitably selected for getting an efficient film cooling effect. To determine the location and orientation of the holes the behavior of the turbulent flow over the wavy wall should be thoroughly investigated through numerical methods by simulating the model of the geometry. Software used for the numerical analysis are GAMBIT (for making and meshing the geometry) and FLUENT (version 6.3.26)(for flow analysis). Since the 3D analysis consumes a lot of computational power and time, a two dimensional analysis of flow over the wavy wall has been carried out. Among the various turbulence models available in FLUENT, a suitable model for the wavy wall geometry has been selected by running cases with different turbulence models on suitable grid (selected through grid independence study) and comparing the results with DNS data available in the literature for that particular wavy geometry. The selected turbulence model is used for the analysis of the actual geometry consisting of a number of holes at different location and oriented at different angles. The comparison of 2D symmetric and 2D axisymmetric model of the actual geometry has been done and from the comparison of results, it is found that the 2D symmetric model well approximates the 2D axisymmetric model of the actual geometry. A parametric study on the 2D symmetric model of the actual geometry with a single hole at different angles has been done for various Reynolds number and blowing ratios. Analyzing the result, the optimum angle of injection and optimum position of hole were found out. On the same geometry, multiple holes have been made and the simulations have been carried out for various values of Reynolds number and blowing ratio. Two different cases of multi-holed geometry have been taken, first with holes on adjacent waves with lower blowing ratio and other with holes on alternate waves with higher blowing ratio. Simulation results showed that former gives better results of temperature distribution. Finally an attempt was made to conduct periodic analysis on flat plate geometry with wall heat flux, with the help of UDF.

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