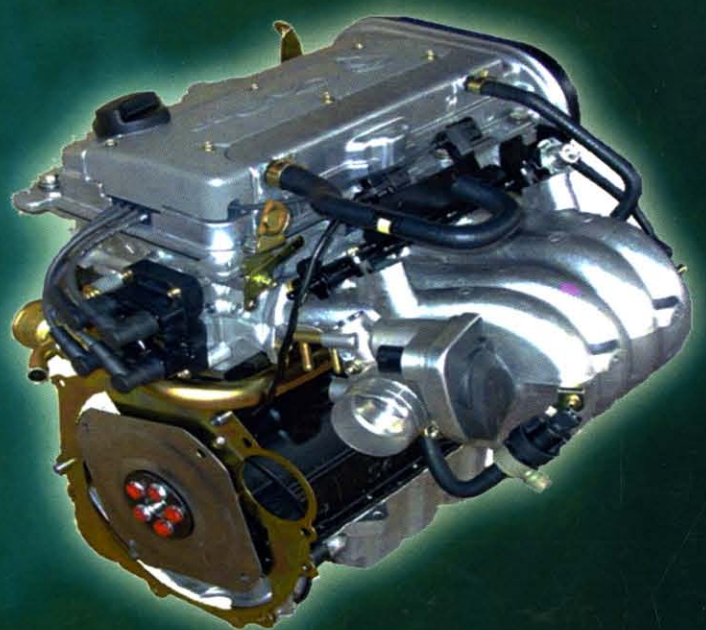
Engine and Auxiliary Systems

Edited by
Prof. Dr. A.K.M. Mohiuddin



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Chapter 30

Film Cooling of Turbine Blades

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Introduction

The problem under investigation here relates to increasing the efficiency of gas turbine engines by means of cooling the aerofoil blades in the turbine section of the engine so that higher inlet temperatures may be allowed. Increasing the temperature of inlet gases is a thermodynamic requirement for increasing the power output and thermal efficiency of gas turbine engines. Higher inlet temperatures subject the aerofoil blades to increased risk of thermal failure and therefore require effective strategies for cooling turbine blades.

Film cooling is commonly employed in order to provide effective blade protection and is accomplished by injecting coolant jets into the crossflow of hot gases from slots or film cooling holes on the blade surface. The injected coolant is bent over by the crossflow and forms a cold film over the blade surface thus protecting it from the extremely hot crossflow gases. Clearly, effective film cooling of turbine blades is of critical importance to the turbine industry and a thorough and methodical investigation of this problem is required so that efficient film cooling strategies may be suggested.

A logical first step in this direction would therefore be to study the flow field created by the interaction of the injected coolant jet and the hot crossflow. To simplify issues further one would tend to study this interaction over a flat surface instead of a curved aerofoil surface so that complexities arising from the curvature of the blade surface may be avoided. This is likely to facilitate the development of analytical tools for representing the simplified film cooling flow interaction. These tools can then be adapted to incorporate the effect of the actual blade geometry leading to the analytical representation of the actual problem. The simplified version of the turbine blade cooling problem involves the injection of a coolant film into a crossflow over a flat plate. This flow configuration is referred to in published literature as the 'Jet In Crossflow' problem. Before discussing the generic jet in a crossflow problem, it is important to comprehend