Experimental investigations of the film cooling effectiveness of a Micro-Tangential-Jet Scheme on a Gas Turbine Vane

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Abstract:

This paper presents experimental investigations of the film cooling effectiveness of a Micro-Tangential- Jet (MTJ) Film cooling scheme on a gas turbine vane using transient Thermochromic Liquid Crystal (TLC) technique. The MTJ scheme is a micro-shaped scheme designed so that the secondary jet is supplied tangentially to the vane surface. The scheme combines the benefits of micro jets and tangential injection. The film cooling performance of one row of holes on both pressure and suction sides were investigated at a blowing ratio ranging from 0.5 to 1.5 on the pressure side and 0.25 to 0.625 on the suction side. The average density ratio during the investigations was 0.93, and the Reynolds Number was 1.4E+5, based on the free stream velocity and the main duct hydraulic diameter. The pitch to diameter ratio of the cooling holes is 5 on the pressure side and 6.5 on the suction side. The turbulence intensity during all investigations was 8.5%. Minor changes in the Mach number distribution around the airfoil surface were observed due to the presence of the MTJ scheme, compared with the case with no MTJ scheme. The investigations showed great film cooling performance for the MTJ scheme, high effectiveness values and excellent lateral jet spreading. The performance of tangential injection over actual airfoil surfaces was found close, qualitatively, to that observed over flat plate. A 2-D coolant film was observed in the results, which is a characteristic of the continuous slot schemes only. The presence of this 2-D film layer helps minimize the rate of mixing between the main and the secondary streams. This film help establish uniform thermal loads on the surface. Furthermore, it was noticed that the rate of effectiveness decay on the suction side was lower than that of the pressure side while the lateral jet spreading on the pressure side was better than on suction side. The main disadvantage of the MTJ scheme is the increased pressure drop across the scheme, compared to traditional shaped schemes.

Keywords:

Gas turbines Film cooling Micro film cooling Tangential injection Effectiveness

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