

Recent Advances in the Study of Inward Flow Cooling of Turbine Blade in Rotating Passages

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Abstract-The development of a new generation of high performance gas turbine engines requires gas turbines to be operated at very high inlet temperatures, which are much higher than the allowable metal temperatures. Consequently, this necessitates the need for advanced cooling techniques. Among the numerous cooling technologies, the inward flow cooling technology has superior advantages and relatively favorable application prospect. The recent research progress of the inward flow cooling of turbine blade in rotating is reviewed. Influence of passage section on heat transfer in rotating and the effect of rotating smooth passage on turbulent flow and heat transfer are discussed. The influence of rotating on impinging cooling and heat transfer of rotating cooling duct with staggered pin fins is also generalized. In the last, it is noted that major problems due for further research include: optimizing of inward passage configuration and synthesis study of rotation effect on flow and heat transfer in pin-fins duct. In addition, the interactional mechanism of inward flow and film cooling will be also investigated thorough.

Keywords- gas turbines; cooling blades; conservative heat transfer; rib; rotating

I. INTRODUCTION

The modern gas turbine engine performance is constantly improved with the compression ratio of the engine and the turbine inlet gas temperature, and cooling structure of engine hot end components become more complex with the increase of gas temperature before the turbine. At this time, turbine blade internal cooling structure and cooling mode become one of the key technologies. Internal cooling is the flow of coolant heat transfer inside the blade passage and absorbs heat from the blade, at present the internal cooling method mainly has the impinging jet cooling, strengthening heat transfer of fin spoiler and heat transfer enhancement rib - column.

The comprehensive effect of turbulence, variation characteristics, surface roughness and channel geometry will influence characteristics of the static blade cooling fluid. Air cooled blade flow and heat of the rotating condition are far greater than the difficulty of the stationary state, because of rotational force to join compared with the stationary blade, which makes the flow analysis of cooling medium one dimension increase, rotational Coriolis force and rotating buoyancy changes the flow field, causing two flow in the channel, thus

affecting the heat transfer. Therefore, the effect of rotation on the turbine internal flow field and heat transfer have a very important role for the design and optimization of gas turbine cooling in order to improve the aerodynamic performance of the turbine.

This paper summarizes the rotating condition, the research results of gas turbine blade internal cooling technology at home and abroad. In addition, the inward flow cooling should be further studied to provide reference for the rational design of turbine blade internal cooling system under rotating state in the future.

II. EFFECT OF ROTATION ON THE FLOW FIELD

There was a significant difference between the rotating channel flow in the channel and the static flow, centrifugal force caused by the static pressure distribution changes in flow in U channel has little effect for the rotation of the turbine blade internal flow, but if the rotation number is large, the centrifugal force on the flow of the air compression effect can't be ignored. Under rotation, Coriolis force will make the flow structure has two significant changes: one is the mainstream to offset the direction of the Coriolis force. The other is a rotating radial velocity by the force caused by the Coriolis two flow, it not only changed the distribution of velocity, velocity fluctuation and random characteristics of turbulence will also change. The main direction and fluid centrifugal buoyancy of the inertial force in the same line, compared to its influence on the flow in the channel with the Coriolis force, in a weak position. Cheah et al. [1] measure rotating speed of the double channel flow using the laser Doppler velocimetry (LDV). The velocity vector diagram shows the flow separation downstream of 180 degrees elbow in Fig. 1. The reattachment length increases the forward rotation, reverse rotation so that the reattachment length decreases. Measurements show that the transverse fluctuation near the elbow matches fluctuation along the streamline direction.

III. EFFECT OF ROTATION ON HEAT TRANSFER

The additional force generated in the rotating turbine blade under the condition of heat transfer enhancement, flow resistance is reduced, but the rotation of the heat exchanger in each surface uneven distribution, increasing the temperature gradient. The buoyancy of centrifugal force will be derived, the near wall heat flux density

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Sebastian Brünink



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