HEAT TRANSFER INVESTIGATION OF THE COOLED SQUEALER TIP SECTION OF A HP TURBINE BLADE

Davide Lengani, Italy
Supervisors: T. Arts & M. Legrand

In the design of modern aero engine one of the most important parameters is the turbine inlet temperature. New materials are developed to operate at high temperatures, but improvements can also be achieved from a better cooling of the blade. Two of the most complex zones from both the aerodynamic and thermal points of view are the blade tip area and the near endwall region.

In the present study heat transfer measurements are made in the tip region of a linear cascade for 2 different outlet Reynolds and Mach numbers. Different Reynolds numbers are necessary to simulate 2 different aero engine behaviors: take off and cruise condition. The outlet Mach number was changed to observe the transonic effects on the heat exchange. Squealer tip geometry, including tip and pressure side film cooling, has been investigated. The cooling massflow and temperature were varied during the experiments.

Thin film gauges were placed on the blade tip (figure 1) along the blade pressure side, the blade rim, and the blade cavity. For the first time in literature the heat flux was measured in a cooled squealer tip rim in transonic conditions. Also the endwall opposed to the blade tip was instrumented with thin film gauges.

The effect of different coolant to freestream massflow ratios has been shown; for high Reynolds number a reduced heat transfer coefficient for all the different blowing ratio is found if compared to the baseline flow. At low Reynolds number the opportune injection has instead to be carefully chosen. The maximum cooling massflow is increasing the mean heat transfer coefficient on the endwall pressure side; while with minimum cooling massflow a high heat transfer coefficient is found on the blade suction side rim.

Different Nusselt number distributions were found for all the 4 different outlet conditions, different tip leakage flow paths are observed at the different Reynolds and Mach number. At low Mach number the parallel work done by Tomáš A. Hofer by means of flow visualization and pressure measurements was helpful for a better understanding of the flow structure.

Figure 1: Instrumented blade tip.