THERMAL PERFORMANCE OF A ROTOR WITH PLATFORM COOLING

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As aero engines manufacturers try to lighten their turbines by reducing the number of stages, the thermal load on the blades rises. In order to minimise thermal damage of the airfoils intensive cooling is required, such as film cooling. The objective of the present study is to evaluate the heat transfer on a blade with platform cooling and with or without hub disk leakage.

Experiments have been conducted in the VKI isentropic compression tube facility CT3. The blades of CT3's rotor have been equipped with thin film gauges at 15, 7.5 % span and on the rotor platform to monitor the steady and unsteady heat transfer. Flat thermocouples were added to the thin film thermometers on the platform.

The data interpretation is focused on the analysis of the heat transfer around the airfoil platform expressed in terms of heat flux. Prior to the blowdown, the turbine is accelerated at around 50 mbar, up to 6500 RPM. During this pre-rotation, the rotor is heated due to friction. This heating leads to a temperature drop across the thin films substrate. It is shown that neglecting this initial temperature distribution leads to an underestimation of up to 40 % of the wall flux. A procedure is proposed to determine this temperature drop using temperature recordings during the pre-rotation and a user-friendly C User Subroutine interfaced with Scheme in Fluent. The one dimensional data processing tool used to extract the wall flux from the wall temperature history has been updated to account for this initial temperature distribution. This methodology is applied to compute the flux at 15% of the span. The influence of the rotational speed on the heat transfer at 15% is discussed.

In the platform nearby, the precedent procedure is not anymore applicable. Thin flat thermocouples are used to measure the temperature below the thin films substrate providing the in-house one dimensional routine with a second boundary condition. It allows overcoming both problems of finite thickness and initial temperature distribution. To account for two dimensional effects or high curvature, several approaches are proposed, the most versatile being to use the same two dimensional data reduction procedure during the test than during the pre-rotation.

Finally, it is proven that the actual wall heat flux can be decomposed in two parts, the first being the flux computed classically by neglecting the initial temperature distribution, the second, constant all along the test being given by the temperature drop across the substrate before the blowdown. This proves that thermocouples can be used despite their low frequency response to reconstruct the actual wall flux.