Film Cooling: What have we learnt from our measurements?

Tony Arts

von Karman Institute for Fluid Dynamics
72, chaussée de Waterloo – B1640 Rhode Saint Genèse – Belgium
Tel: +32-(0)2-359.9611 Fax: +32-(0)2-359.9600 Email: arts@vki.ac.be

The strong interest devoted to the convective heat transfer phenomena existing in the first stages of a modern high pressure gas turbine is motivated by the important thermal loads observed in this severe environment. An efficient cooling of the vanes, blades and endwalls is most often required to prevent their early degradation. Film cooling is one of the techniques commonly applied for this purpose. Considering the complexity of the flow developing in modern aero-engines, an experimental approach in conditions and with models representative of reality is absolutely necessary. A large number of experimental research programs have therefore been undertaken over the four last decades to investigate numerous aspects of the film cooling technique.

A lot of parameters have to be considered to correctly simulate the geometry and the flow conditions encountered in modern gas turbines: airfoil geometry, coolant emission location and geometry, gas to wall temperature ratio, blade loading, free-stream Reynolds number, free-stream turbulence intensity, secondary flows, coolant to free-stream mass weight and temperature ratios, … etc.

The present contribution will try to address a number of these topics, based upon the experience gained during a number of years of research at the von Karman Institute and of joined collaboration with industry. It will try to put in evidence the lessons learned from these experimental “film cooling” research programs, both from a heat transfer and an aerodynamic point of view.