CONJUGATE HEAT TRANSFER IN TRANSIENT REGIME
APPLICATION TO AN IMPINGING JET

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Thermal efficiency and power output of gas turbines increase with increasing turbine inlet temperature. State-of-the-art gas turbines are designed to operate at turbine inlet temperatures in excess of 1850 K. Since the super-alloys commonly employed in highly loaded components exposed to the combustion gases cannot withstand temperatures above 1350 K, effective cooling concepts are required in order to assure durability and long operating intervals.

The purpose of this project is to characterize the conjugate transient heat transfer coefficient and to asses changes with respect to time and space. To be able to accomplish this goal, a jet impingement experiment has been conducted on a cylindrical metal slab heated from the bottom with heat transfer through the top wetted surface by jet impingement. After the initial steady state conditions are reached, at time t=0 a step change in jet air temperature is imposed and through infrared thermography temporal and spatial temperature distributions are acquired.

These temperature distributions resulted in heat transfer coefficient distributions through a time accurate finite element model of the slab. From the experiments conducted, it has been observed that the heat transfer coefficient defined in reference to the bulk jet air temperature resulted in transient deviations of heat transfer coefficients up to 80% and steady deviation up 40%. It is well understood that the heat transfer coefficient must be invariant under such conditions both in transient and among two different steady states where the aerodynamic phenomenon remains the same and suggestions are made to better define a new reference temperature such that the true decoupling of the fluid-solid interface can be achieved.

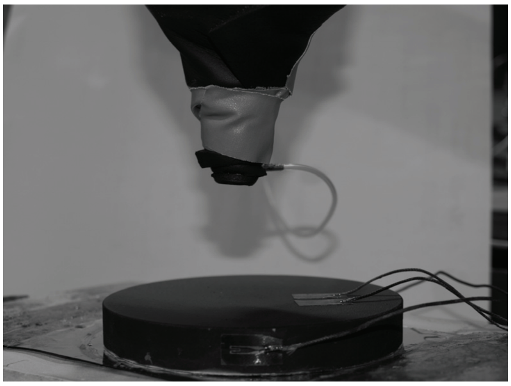

Figure 1: Jet impingement configuration

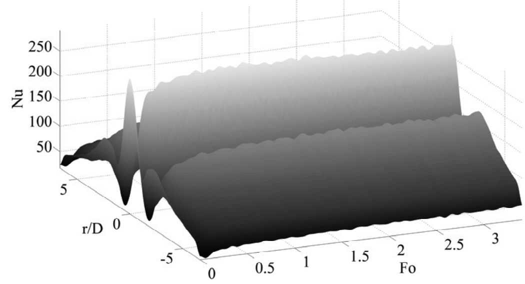

Figure 1: Experimental Nusselt number distribution in time and space