CONJUGATE HEAT TRANSFER ANALYSIS OF NASA C3X FILM COOLED VANE

WITH AN OBJECT-ORIENTED CFD CODE

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Abstract

This paper presents the developments done on a CFD unstructured solver to perform conjugate heat transfer simulations in turbomachinery applications. The solver uses a SIMPLE-C All-Mach algorithm with a special treatment for the pressure corrector equation to deal with highly compressible flows.

Moreover, the solver provides an exhaustive turbulence model library, specific for heat transfer calculations and an implicit treatment for fluid-to-fluid and solid-to-fluid boundaries using a generic grid interface (GGI) that allows a greater mesh generation flexibility. The development of the generic grid interface is described in the current paper.

The conjugate numerical methodology was employed to predict the metal temperature of a three-dimensional first stage gas turbine blade at realistic operating conditions.

The validation case is based on the 1988 NASA C3X experimental setup of a internally and film cooled vane. The stator vane was internally cooled by an array of radial cooling channels of constant cross-sectional area an externally by rows of film cooling holes.

The mesh has been generated with GridPRO, using a multi block structured approach. The optimization methods used in the grid generator provide a full hex grid maintaining mesh orthogonality at the walls and within the domain and allowing the nodes to be moved to an optimal position.

Numerical and experimental results are compared in terms of pressure and temperature distribution on the blade wall at mid-span, as well as heat transfer coefficient profiles.

Key words: Conjugate Heat Trasfer, film cooling, turbomachinery

References

[1] Hylton, L. D., Nirmalan, V., Sultanian, B. K., and Kaufman, R. M., 1988. *The effects of leading edge and downstream film cooling on turbine vane heat transfer*. Tech.Rep. 168015, NASA, Allison Gas Turbine Division, Indianapolis, Indiana.