

EXPERIMENTAL AND COMPUTATIONAL STUDIES OF FILM COOLING WITH COMPOUND ANGLE INJECTION

Final Report

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Executive Summary

AGTSR FINAL REPORT
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Project Title:

Experimental and Computational Studies of Film Cooling with Compound Angle Injection

AGTSR Subcontract No.: 94-01-SR-021

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The University of Minnesota program is a combined experimental and computational study of various film-cooling configurations. Whereas a large number of parameters influence film cooling processes, this research focuses on compound angle injection. Appreciation of the advantages of compound angle injection has risen recently with the demand for more effective cooling and with improved understanding of the flow; this project contributed to further this understanding.

Approaches include: (1) a new measurement system that extends the mass/heat transfer analogy to obtain both local film cooling and local mass (heat) transfer results in a single system, (2) direct measurement of three-dimensional turbulent transport in a low free-stream turbulence flow and a highly distributed flow, (3) measurement of film cooling effectiveness with in-flow temperature field measurements, (4) the use of compound angle and shaped holes to optimize film cooling performance, and (5) and exploration of anisotropy corrections to turbulence modeling of film cooling jets.

The outcome of this research, to be summarized herein, is threefold. First, it provides fundamental scientific information in the form of detailed measurements, computational results, and turbulence model validation. Second, the results of the experiments and computations are presented in a generalized form so that they will directly usable by design engineers in industry. Providing input to numerical computation tools is one means by which these data are generalized. Finally, the experimental computational activities will be used to familiarize graduate and undergraduate students with the gas turbine industry.