AERONAUTICAL ENGINEER

ANALYSIS OF THE TIP LEAKAGE FLOW FIELD IN AN AXIAL TURBINE

Charles S. Anderson-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1983
Aeronautical Engineer-June 1999
Master of Science in Aeronautical Engineering-June 1999
Advisor: Garth V. Hobson, Department of Aeronautics and Astronautics
Second Reader: Raymond P. Shreeve, Department of Aeronautics and Astronautics

Comparisons of experimental laser Doppler velocimetry measurements using the Naval Postgraduate School cold-flow turbine test rig were made with 3D viscous computational fluid dynamics flow solutions. The turbine tested was the first stage of the Pratt and Whitney designed Space Shuttle Main Engine High Pressure Fuel Turbopump. The laser anemometer was modified to incorporate a field stop, which acted as a spatial filter to limit reception of undesired blade reflections. The laser measurements were made in the endwall region of the test turbine, at three axial locations, and at three radial depths. For each location, absolute flow angle, axial and tangential velocity ratios, turbulence intensities, and correlation coefficients were measured. The computational effort encompassed modeling a single blade passage of both the stator and the rotor and computing flow solutions of the stage using NASA software. Exit plane and endwall flow property profiles showed good agreement when compared with experimental data. A quasi-three-dimensional flow analysis of stator wake/rotor flow interaction was completed to investigate the unsteady effects neglected when "plane averaging" flow properties between grids during the full three-dimensional simulation.

DoD KEY TECHNOLOGY AREA: Aerospace Propulsion and Power

KEYWORDS: Laser Doppler Velocimetry, Computational Fluid Dynamics, Turbine Endwall Flow Analysis