PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

High Efficiency Engines and Turbines

12/2002

IMPROVED PERFORMANCE AND DURABILITY IN GAS TURBINES THROUGH AIRFOIL CLOCKING AND HOT STREAK MANAGEMENT

PRIMARY PROJECT PARTNER

Virginia Commonwealth University

TOTAL ESTIMATED COST

$ 189,639

CUSTOMER SERVICE

800-553-7681

STRATEGIC CENTER FOR NATURAL GAS WEBSITE

www.netl.doe.gov/scng

Description

Under the Advanced Gas Turbine Systems Research (AGTSR) program, Virginia Commonwealth University (VCU) is leading a team of researchers at three universities who are evaluating the effects of circumferentially positioning (clocking) the airfoils in the fixed rings of vanes in turbines. Task 1 of the project performs baseline design flow simulations for a high-pressure turbine geometry from a representative land-based gas turbine. Predicted baseline computer solutions are then compared with available experimental data. Tasks 2 through 4 perform hot streak simulations for the specified turbine using various shapes for the hot streak pattern, without and with clocking. Task 5 optimizes stage performance and alleviates airfoil thermal gradients through airfoil clocking and hot streak management. Based on the results of Tasks 2-5, Task 6 develops design guidelines for improving the efficiency and durability of turbine stages.

Computational analyses to date have shown a sinusoidal dependence of the aerodynamic efficiency of a second stage vane row with respect to the circumferential position of its vanes relative to the vanes in the first stage row. As shown in Figure 1, the amplitude is about one percent for the variation in efficiency. The maximum efficiency occurs at a clocking position where the low momentum fluid from the first stage vanes impinge on the second stage vanes. These results provide information to turbine designers for positioning fixed vanes in rows on the two sides of a rotor row to maximize aerodynamic efficiency.

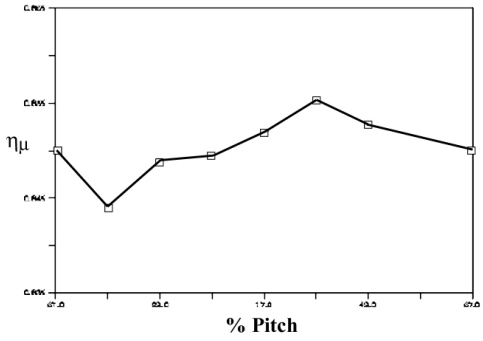

Figure 1. Time average efficiency versus clocking position

Improved Performance and Durability in Gas Turbines Through Airfoil Clocking and Hot Streak Management

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Duration

24 months

Goals

Perform numerical calculations to investigate the relative positioning of fixed vanes on either side of a rotating blade row to alleviate two major factors affecting the performance and durability of gas turbine engines, flow unsteadiness and thermal gradient stresses.

Benefits

- A numerical data base for use to optimize inter-stage performance of gas turbines
- Design guidelines for improving efficiency and durability of gas turbines through airfoil clocking and hot streak management