the ENERGY lab

PROJECT FACTS

Hydrogen Turbines

Demonstration of Enabling Spar-Shell Cooling Technology in Gas Turbines — Florida Turbine Technologies

Background

The Florida Turbine Technologies (FTT) spar-shell gas turbine airfoil concept has an internal structural support (the spar) and an external covering (the shell). This concept allows the thermal-mechanical and aerodynamic requirements of the airfoil design to be considered separately, thereby enabling the overall design to be optimized for the harsh environment these parts are exposed to during operation. Such optimization is one of the major advantages of the spar-shell approach that is not possible with today's conventional monolithic turbine components.

The proposed design integrates a novel cooling approach based on Advanced Recirculating Total Impingement Cooling (ARTIC™) to improve heat transfer and allow higher turbine operating temperatures and/or a reduction in cooling flow. Taken together, the optimization of higher operating temperatures and better cooling with less flow will lead to turbines that are more efficient, have longer life, and consequently generate power at a lower cost of electricity.

This project was competitively selected under the Small Business Innovative Research (SBIR) Program. It is managed by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL). NETL is researching advanced turbine technology with the goal of producing reliable, affordable, and environmentally friendly electric power in response to the nation's increasing energy challenges. With the Hydrogen Turbine Program, NETL is leading the research, development, and demonstration of these technologies to achieve power production from high hydrogen content fuels derived from coal that is clean, efficient, and cost-effective, minimizes carbon dioxide (CO_2) emissions, and will help maintain the nation's leadership in the export of gas turbine eqipment.

Project Description

The scope of this SBIR Phase III project includes the design, analysis, fabrication, assembly, installation, and testing of prototype spar-shell turbine airfoils and associated hardware, culminating in the validation of performance and functionality in a commercial gas turbine.

Goals/Objectives

The objective of this project is to develop and test–at a commercial prototype scale–first-stage, spar-shell turbine airfoils requiring significantly less cooling flow than the current state-of-the-art. The benefits of this technology are compelling,

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PARTNERS

Siemens Energy

PROJECT DURATION

Start Date	End Date
07/08/2011	12/31/2013

COST

Total Project Value
$1,707,140

DOE/Non-DOE Share
$1,310,845/$396,295

AWARD NUMBER

FE0006696

U.S. DEPARTMENT OF ENERGY

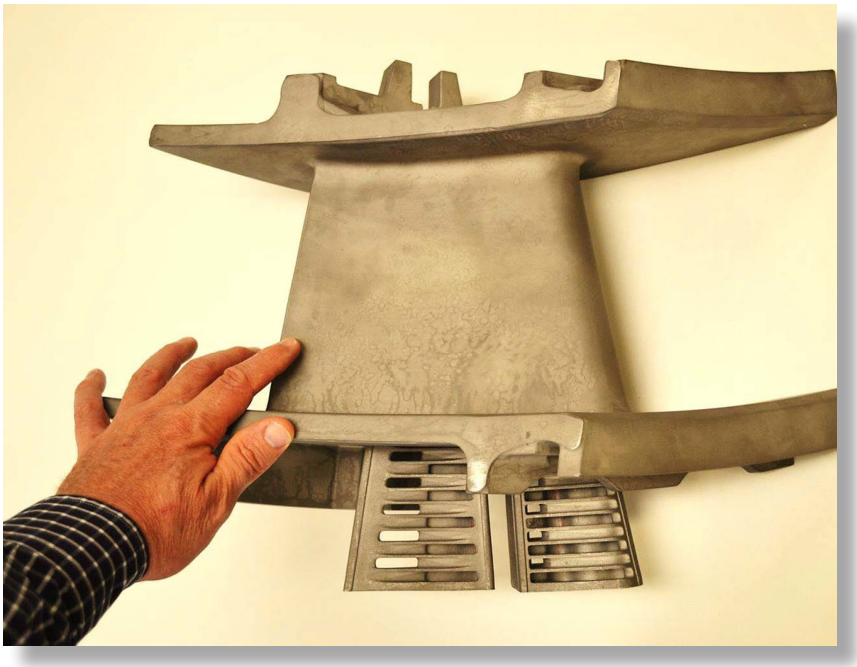
with studies indicating the combined cycle efficiency of current F-frame gas turbine-based power plants could be increased one percent (i.e.: from 60 to 61%) with the incorporation of this technology within the first three rows of airfoils in the gas turbine. Successful engine test validation of spar-shell airfoils in this project will open the door to commercialization of this new technology in both F-frame and other highly-cooled turbine airfoil applications. FTT's commercialization plan includes production of saleable components for new and retrofit applications.

Accomplishment

- Produced a viable design concept which continues to be developed within the detailed design phase.
- Completed extensive engineering calculations and analysis of the feasibility of the mechanical design, including cooling and structural aspects.
- Conducted failure modes and effects analyses (FMEA's) to identify the pertinent technical risks and to define mitigation plans to counter these risks.
- Established an agreement with Siemens Energy, Inc., to participate in this project.
- Identified a suitable test vehicle, and a target date for insertion of spar-shell turbine components into thatvehicle was defined.
- Performed high-fidelity thermal and structural analyses to support the feasibility of the detailed design.
- Completed the detailed design of a spar-shell vane.
- Released casting details to production.
- Completed design verification and validation testing of the heat transfer and sealing aspects of the design.
- Completed detailed design reviews.
- Facilitated fabrication feasibility and cost assessments with FTT manufacturing and procurement support.
- Completed product definition (drawings, computer-aided design (CAD) models, etc.).
- Fabricated prototype models to demonstrate/illustrate the design concept and to prove the manufacturing feasibility of the concept.
- Completed definition of instrumentation requirements and wrote instrumentation specification.
- Completed manufacture of airfoil (shell) castings.
- Completed manufacture of internal spar castings.

Benefits

This SBIR project supports DOE's Hydrogen Turbine Program that is striving to show that gas turbines can operate on coal-based hydrogen fuels, increase combined cycle efficiency by three to five percentage points over baseline, and reduce emissions. The SBIR program is positioned to leverage the agility and innovative competencies of small businesses. It is through this program that a small company, Florida Turbine Technologies, has developed a potential breakthrough technology for turbine airfoils with significantly improved cooling efficiency. Continued investment in this small business will likely result in U.S. engineering and manufacturing jobs.



FTT Spar-Shell Vane under Construction for Test in a Large-Scale Industrial Gas Turbine Engine.