Advanced Hot Section Materials and Coatings Test Rig

Report: Quarterly Report
Reporting Period Start Date: 10/01/03
Reporting Period End Date: 12/31/03
Principal Author: Scott Reome/Dan Davies
Report Date: January 2004
DOE Award Number: DE-FC26-03NT41888

Florida Turbine Technologies, Inc.
140 Intracoastal Pointe Drive, Suite 301
Jupiter, FL 33477

"This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

Abstract:

The Hyperbaric Advanced Hot Section Materials & Coating Test Rig program initiated this quarter, provides design and implementation of a laboratory rig capable of simulating the hot gas path conditions of coal-gas fired industrial gas turbine engines. The principle activity during this first reporting period were preparing for and conducting a project kick-off meeting, working through plans for the project implementation, and beginning the conceptual design of the test section.

Table of Contents:

Introduction

Executive Summary

Experimental

Results and Discussion

Conclusion

References

List(s) of Graphical Materials:

Figure 1. Conceptual design of a multiple, parallel, transversely-mounted specimen Hyperbaric Advanced Hot Section Materials & Coating Test Rig

Figure 2. Conceptual design of a multiple, stacked, transversely-mounted specimen Hyperbaric Advanced Hot Section Materials & Coating Test Rig

INTRODUCTION

This is the first quarterly report of technical progress on contract # DE-FC26-03NT41888 for the Hyperbaric Advanced Hot Section Materials & Coating Test Rig in which Phase I was awarded to Florida Turbine Technologies (FTT) in October, 2003. The objectives of Phase I are to complete conceptual design studies, downselect a configuration, and execute a detail design of the rig test section. Additional goals of this phase include conceptual definition of auxiliary systems and facilities, and preparing plans for permitting and implementation. In Phase II, a prototype test section will be fabricated and tested, and designs for auxiliary systems and facilities completed, and rig hardware fabricated, equipment purchased, and test facilities constructed. Phase III completes the project with the installation of the rig, checkout and demonstration.

EXECUTIVE SUMMARY

The Hyperbaric Advanced Hot Section Materials & Coating Test Rig Phase I activity was initiated during this quarter. Florida Turbine Technologies will design and implement a laboratory rig capable of simulating the hot gas path conditions of coal gas fired industrial gas turbine engines. Potential uses of this rig include investigations into environmental attack of turbine materials and coatings exposed to syngas, erosion, and thermal-mechanical fatigue.

The principle activity during the current period were finalizing the project staffing, conducting a project kick-off meeting, preparing plans for the project implementation, and beginning the conceptual design of the test section.

A project kickoff meeting was held at NETL; the objective of this meeting was to ensure mutual understanding of the program objectives and the technical approach proposed by FTT. During this meeting several relevant discussions ensued, however no technical or contractual issues were identified.

FTT has begun working with project partners Siemens Westinghouse Power Corporation and Dakota Gasification Company regarding rig operation with a syngas combustor fuel nozzle, fuel composition, emissions, and the integration of an on-line thermal barrier coating monitoring system.

Conceptual designs were initiated, focusing on rig configurations whereby multiple test specimens are arranged transverse to the hot gaspath. The test specimens are internally cooled to result in a coating or substrate temperature of interest. The rig is being designed to also accommodate thermal-mechanical fatigue testing.

The first program milestone was achieved with the completion of an internal review to identify potential problems, necessary changes, and to agree upon analysis methods and criteria. Action items identified are to be addressed in the next reporting period during the continuation of the conceptual design task.

EXPERIMENTAL

This project provides for the design and implementation of a laboratory rig capable of simulating the hot gas path conditions of coal gas fired industrial gas turbine engines. Potential uses of this rig include investigations into environmental attack of turbine materials and coatings exposed to syngas, erosion, and thermal-mechanical fatigue.

RESULTS AND DISCUSSION

The principle activity during the current period were finalizing the project staffing, conducting a project kick-off meeting, preparing plans for the project implementation, and beginning the conceptual design of the test section. A summary of activities in each of these tasks is summarized below.

Following contract award, the FTT staffing plan was finalized as follows:

- Program Manager – Scott Reome
- Principle Investigator – Daniel Davies
- Combustion – Lindsay Morton
- Heat Transfer – Todd Ebert
- Systems Design – Dave Huber

A project kickoff meeting was held at NETL with Scott Reome and Dan Davies attending from FTT. Also in attendance was the FTT president, Joe Brostmeyer. NETL attendees were Lane Wilson, Chuck Alsup, Geo Richards and Bruce Utz. The objective of this meeting was to ensure mutual understanding of the program objectives and the technical approach proposed by FTT. Following a presentation of the prepared briefing material¹, several relevant discussions ensued relative to measurement of actual test conditions, failure detection, and variation in syngas chemistry. No technical or contractual issues were identified.

Discussions were also held with FTT's corporate partners in the project, Siemens Westinghouse Power Corporation (SWPC) and Dakota Gasification Company (DGC). A purchase order was issued to SWPC to provide details of the V64.3A combustor pilot nozzle for possible conversion to burn syngas and for use in the rig combustor, to support in the integration of the SWPC on-line thermal barrier coating (TBC) monitoring system, and to help coordinate the prototype rig test at Siemens Pittsburgh planned for Phase II. Meetings between FTT and DGC exchanged information on fuel gas compositions and estimated emissions.

Conceptual design development was initiated during this period. Rig configurations being investigated in this phase of the program provide for testing of multiple specimens arranged transverse to the hot gaspath. One of these test section conceptual designs is shown in Fig 1. The test section consists of a combustor, a test section housing and an exhaust chamber. The air supply for the rig is from an electric motor-driven industrial compressor. The air is ducted to the rig combustor, a can-type chamber with a syngas fuel injector. A transition section ducts the exhaust gas into a test section, across which a series of parallel test specimens are positioned.

¹ PowerPoint presentation, Scott Reome to NETL, December 16, 2003

The test specimens are internally cooled from the same air supply, to coating or substrate temperatures of interest. Thermal-mechanical fatigue (TMF) testing may be conducted by applying a known tensile load to the specimens concurrent with thermal cycling.

Figure 1. Conceptual design of a multiple, parallel, transversely-mounted specimen Hyperbaric Advanced Hot Section Materials & Coating Test Rig

An alternative test section configuration is shown in Figure 2. Multiple test specimens can be accommodated by stacking end-to-end along the length. This arrangement also features internally cooled test specimens that may be tensile loaded for TMF tests.

Figure 2. Conceptual design of a multiple, stacked, transversely-mounted specimen Hyperbaric Advanced Hot Section Materials & Coating Test Rig

The program milestone for the first quarter was met on January 9, 2004 with an FTT internal review which covered the current design concepts, identified potential problems, recommended changes, and reviewed analysis methods and design criteria. Action items identified that pertain to the rig concepts being evaluated in this program were: contact coating suppliers to determine the feasibility of TBC coating the gaspath surfaces of the test section housing, to assess potential test results for specimens located at various positions within the rig, to evaluate methods of detecting failed test specimens, and to identify required test instrumentation.

CONCLUSION

During the first quarter since program start, project staffing has been finalized, a kick-off meeting was held at NETL, FTT and our corporate partners SWPC and DGC have begun to share information for project implementation, and conceptual design of the test section has been initiated. In the following quarter, conceptual design will continue with the generation of alternative configurations, and further development and analysis of selective designs. This information will be used to downselect a final test section and combustor configuration, scheduled to occur in the 3rd quarter.

REFERENCES

1. PowerPoint presentation, Scott Reome to NETL, December 16, 2003