EVALUATION OF IMPACTS OF ALTERNATIVE LIQUID FUELS ON ADVANCED GAS TURBINE MATERIALS

OVERVIEW

A critical element of gas turbine design is the selection of materials. This is especially true with marine applications. Materials used in marine gas turbines and waste incinerators must be able to withstand corrosion due to exposure to combustion products in a high-temperature environment. The UC Irvine Combustion Laboratory and the Energy Systems Materials Group were approached by the Office of Naval Research (ONR) to develop and operate a test facility for materials. The test facility will simulate engine conditions by exposing material test coupons to hot combustion products over a long period of time (1000 hours per test). A burner was developed that can accommodate a variety of liquid fuels, while simultaneously introducing contaminants that would be found in marine environments (such as seawater). Other hardware allows for the thermal cycling, as well as monitoring of the overall system.

GOALS

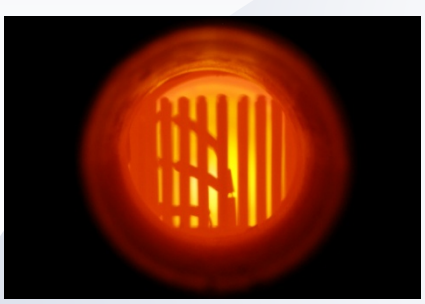
➢Design a test facility in order to expose materials to hot combustion products and contaminants to study material corrosion

➢Design and evaluate a burner which can operate on multiple liquid fuels while simultaneously injecting multiple contaminants, and verify its combustion performance

➢Conduct tests to evaluate materials performance.

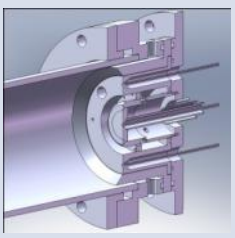
RESULTS

The final design for the test facility consists of a furnace, a thermal cycling unit, and all associated hardware and electronics. The furnace was designed to maintain the test coupons at a specific temperature. It incorporates a burner which generates combustion products, and electronically controlled furnace heaters to maintain constant temperature. The thermal cycling unit allows the test coupons to be returned to ambient conditions during the tests in order to inspect and document the corrosion performance.

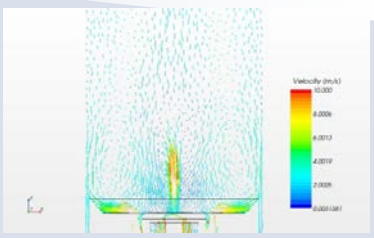


Test Coupons Undergoing Exposure Tests

Assembled LVBR



Solidworks Design Model Of Burner

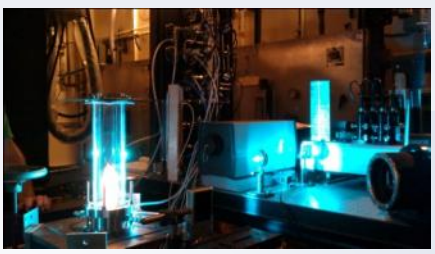


CFD SimulationOf Burner

RESULTS (continued)

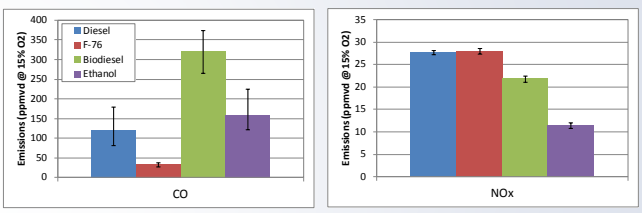
The burner was designed to simulate gas turbine combustion. A single plain-jet airblast atomizer is used for the combustion fuel, with four similar atomizers used for contaminant injection. Combustion air is introduced into the system in a swirling motion, mixing the fuel and air with the contaminants and stabilizing the flame. Computation Fluid Dynamics (CFD) simulation was used to verify the fluid flows of the burner.

Extensive experimental testing of the burner was done using #2 Diesel and F-76 Naval Distillate to verify the operation of the burner and evaluate the combustion performance. Emissions data for these fuels and for Biodiesel, and Ethanol were gathered to ensure that the burner could produce stable combustion for a variety of different fuels, as well as provide insight into the combustion process for these fuels.



Burner Shakedown Test Setup

Stable diesel flame



Steady State Emissions for Different Fuels

PERSONNEL

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