Advanced Combustion Technologies for Gas Turbine Power Plants

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1. Executive Summary

A research and development program was lunched in the fall of 1993 with a focus on flow control. Specifically, the goals of the program were to:

- Develop methodologies for the enhancement of mixing between two fluids to assist in the performance of ultra lean burn gas turbine combustors, and,
- Develop new materials for actuators for use in environments of elevated temperature.

The flow control aspect of the project addressed the development of active mixing control between jets and surrounding fluid. Several actuation methodologies were developed, using different types of actuators; piezoceramic, acoustic, and mechanical. The mixing of jets was examined in a stagnant environment, in a co-flow, and in the presence of a strong acoustic background.

The means of jet mixing enhancement included several active methodologies and also passive-geometrical means. Emphasis was put on the potential for practical applications, and therefore a minimum number of moving parts and energy input were stressed. Several, real-time, actuation schemes were developed, which generated interest on both a national and international level.

New high temperature piezoelectric materials were synthesized. The materials were of the $A_2B_2O_7$, example Strontium Niobate [$Sr_2(Nb_xTa_{1-x})_2O_7$], type with Curie temperatures of 1300^{o}C, compared to 300^{o}C for PZT. The materials were synthesized using several methods which lead to improved grain structure. Examination of the piezoelectric properties of the materials revealed a d_{33} coefficient which was too low to be useful for actuators (a factor of 50 lower than PZT). Potential application for use as

sensors is being investigated. To attain actuation new materials with a Curie temperature of about 600^{o}C will have to be developed.

As part of the work a versatile test combustor was assembled to test the new high temperature materials and the mixing enhancement schemes.

The project resulted in contacts with several members of the gas turbine industry, as well as FETC in Morgantown. These contacts with industry led to the placement of several summer interns, to the delight of the industry, and the planning of future joint projects, and the hiring of one graduate from the Reacting Flows Lab at Virginia Tech.

This work on mixing enhancement and control of jets continues at the present; not funded, in order to bring the ideas closer to technological realization.