Impact of Non-Methane Hydrocarbons

OVERVIEW

In large-scale (utility) and medium-scale (co-generation) applications, gas turbine systems are commonly used for power generation. Recently, premixed natural gas-fired combustors have been utilized to achieve reduced NOx emissions in an effort to build more environmentally sensitive combustion systems. The Department of Energy Advanced Turbine Systems (ATS) initiative has been introduced in premixed natural gas systems. A major question is the extent to which this mixing is necessary to minimize pollutants, especially NOx. The UCI program addresses this question using premixers amenable to parametric variation as well as a research combustor operating at atmospheric and practical conditions.

GOALS

The UCI program also involves a strategy to (1) determine fundamental mixing concepts, (2) application of these concepts to attain high performance, and (3) application of an “active” control system to maintain high performance over any operation condition.

10% Center Pilot

Fuel No Pilot

RESULTS

The Rapid PreMixing (RPM) project was initiated as part of the ATS program in an effort to develop a gas turbine combustor that can emulated a pre-mixed combustor (CPM) without fuel and air mixing upstream of the swirler, thereby preceding the safety concerns regarding flashback and autoignition. The strategy ultimately adopted was to design a combustor consisting of independently functional modules (Figure 1). Such an approach provides numerous capabilities, including:

- Multi-Parameter Control (e.g., fuel distribution, residence time & swirl strength)
- Experimental Flexibility and Interchangeablility
- Direct Sensor Incorporation
- Liquid Fuel “Ready”
- Independent Fuel & Air Injection Temperatures

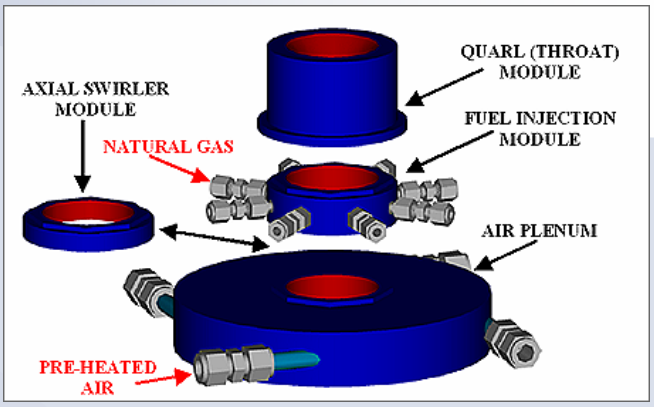

Figure 1: Modular strategy of RPM premixer

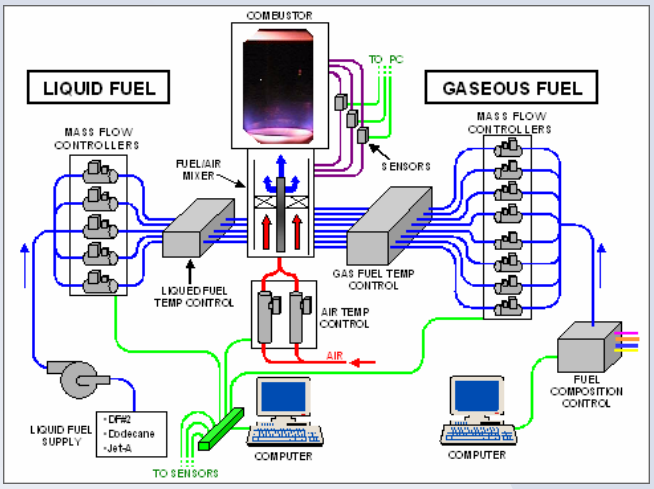

Figure 2: Schematic of active control strategy

One of the utmost characteristics of the RPM modular design approach is its amenability to active control techniques (Figure 2). Through the use of a search and optimization algorithm, the RPM will be able to locate the best set of input system parameters to achieve optimum operating conditions for any desired load within the system’s duty cycle.

PAPERS & PUBLICATIONS

IMPACT OF ETHANE & PROPANE VARIATION IN NATURAL GAS ON THE PERFORMANCE OF A MODEL GAS TURBINE COMBUSTOR (2003). ASME J. Engr. Gas Turbines And Power, Vol. 125, No. 3, pp. 701708 (R.M. Flores, V.G. McDonell, and G.S. Samuelsen)

MEASUREMENT OF FUEL MIXING AND TRANSPORT PROCESSES IN GAS TURBINE COMBUSTION (2000). Measurement Science And Technology, Volume 11, Pp. 870-886 (V.G. McDonell and G.S. Samuelsen).

ACTIVE CONTROL FOR THE OPTIMIZATION OF A GAS TURBINE COMBUSTOR (2004). Submitted to Combustion Science and Technology (M.M. Miyasato, V.G. McDonell, and G.S. Samuelsen)

PERSONNEL

Investigators: G.S. Samuelsen, V.G. McDonell
Staff: R.L. Hack