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TRANSIENT FLOW COMBUSTION

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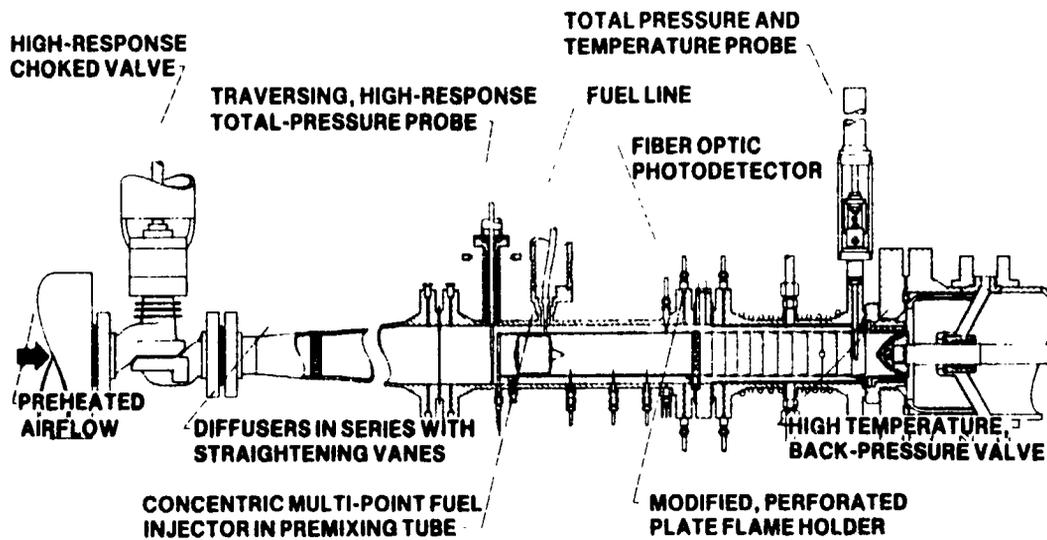
Non-steady combustion problems can result from engine sources such as accelerations, decelerations, nozzle adjustments, augmentor ignition, and air perturbations into and out of the compressor. Also non-steady combustion can be generated internally from combustion instability or self-induced oscillations. A premixed-prevaporized combustor would be particularly sensitive to flow transients because of its susceptibility to flashback-autoignition and blowout. An experimental program, the "Transient Flow Combustion Study" is in progress to study the effects of air and fuel flow transients on a premixed-prevaporized combustor.

This experiment is to be performed at LeRC CE5b, test stand 3. The transient capability is provided by high response hydraulic valves (full traverse in 100 ms) that are installed upstream and downstream of the test section to control airflow and pressure and in the fuel line to control fuel flow. Figure 1 shows the salient features of the test rig and the hardware. Nonvitiated preheated air flows through the upstream control valve to a diffuser section with straightening vanes to provide a uniform velocity profile to the test section. The inlet velocity profile is measured with a traversing total pressure probe. Test hardware for lean premixed-prevaporized combustor tests is shown. The airflow splits at the test section inlet. Half the air goes through the center zone for premixing- prevaporizing with the fuel and downstream burning. The other half enters an outer annulus and is used for film cooling in the downstream burning section. In the center zone, fuel is distributed uniformly by a concentric multi-point fuel injector. The fuel injector can be located either 15 cm or 38 cm upstream of the flameholder. The fuel-air distribution is measured in a plane 4 cm upstream of the flameholder with a traversing probe. High response pressure transducers, thermocouples and a photodetector are installed in the premixing-prevaporizing section to monitor transient response, in particular to detect if autoignition or flashback should occur. Downstream of the premixing-prevaporizing section there is a perforated plate flameholder and a combustion section. The walls of the flame tube are film cooled. The exit conditions will be measured with a traversing total pressure, temperature and emissions probe. Emission measurements will only be taken at steady state conditions. The back pressure valve is a specially designed water cooled valve. This eliminates the need to cool the combustor exhaust products with water spray upstream of the back pressure valve. Water spray upstream of the valve can introduce flow transients if there is two-phase flow.

Preliminary tests have been performed at an inlet air temperature of 600 K, a reference velocity of 30 m/s, and a pressure of 700 kPa. Ramping the airflow down (at constant fuel-air ratio) indicated that this combustor is less sensitive to flashback than anticipated. The airflow was reduced to 1/3 of its original value in a 40 ms ramp before flashback occurred. Ramping the airflow up has shown that blowout is more sensitive than flashback to flow transients. Blowout occurred with a 25 percent increase in airflow (at a constant fuel-air ratio) in a 20 ms ramp. Combustion resonance has been found at some conditions and may be important in determining the effects of flow transients.

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TRANSIENT-FLOW STUDY COMBUSTOR RIG



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