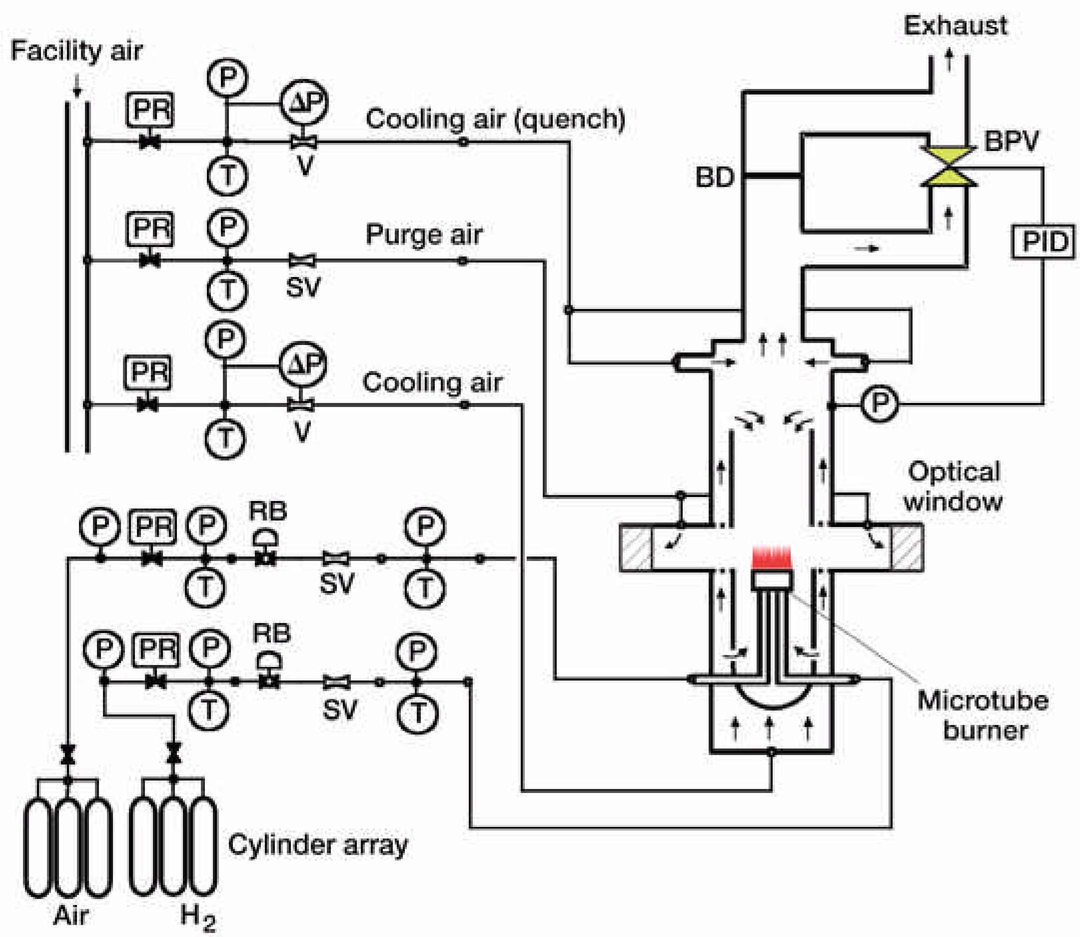
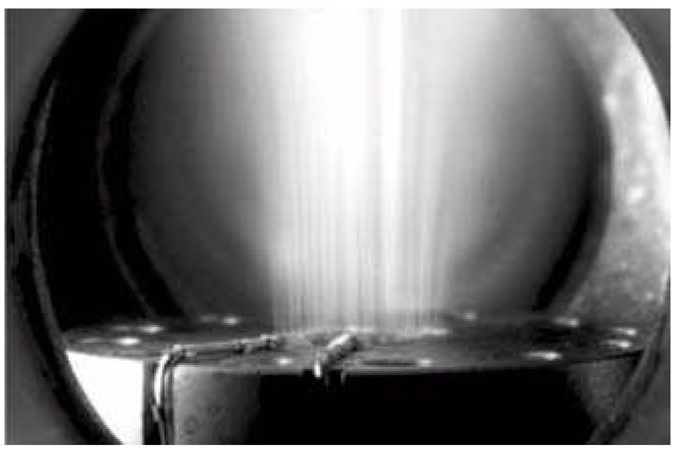
High-Pressure Gaseous Burner (HPGB) Facility Became Operational

A gas-fueled high-pressure combustion facility with optical access, developed over the last 3 years, is now collecting research data in a production mode. The High-Pressure Gaseous Burner (HPGB) rig at the NASA Glenn Research Center can operate at sustained pressures up to 60 atm with a variety of gaseous fuels and liquid jet fuel. The facility is unique because it is the only continuous-flow, hydrogen-capable 60-atm rig in the world with optical access. It will provide researchers with new insights into flame conditions that simulate the environment inside the ultra-high-pressure-ratio combustion chambers of tomorrow's advanced aircraft engines. The facility provides optical access to the flame zone through four fused-silica optical windows, enabling the calibration of nonintrusive optical diagnostics to measure chemical species and temperature. The data from the HPGB rig enable the validation of numerical codes that simulate gas turbine combustors.



High-pressure gaseous burner rig and gas flow system. P, pressure transducer; T, thermocouple; PR, remotely operated regulator; RB, remotely operated ball valve; V, venturi; SV, sonic venturi; BPV, back-pressure valve; PID, process controller; BD, burst *disk.*

This schematic shows the high-pressure burner rig and gas flow system. For pressures up to 30 atm, ambient-temperature air from the facility 450-psi compressor provides the 30-atm cooling air. For pressures above 30 atm, the cooling air is provided by a compressed-air tank array mounted on a trailer. The cooling air is introduced at the bottom of the rig for liner cooling (0.25 lbm/s maximum) and is introduced at the upper side as "quenching" airflow (0.20 lbm/s maximum). These airflows are controlled by remotely operated regulators using calibrated venturi flowmeters. Approximately 10 percent or less of the total cooling flow rate of the facility air is used as purge flow for the optical windows during experiments to prevent water vapor condensation on the interior surfaces of the windows. The rig chamber pressure is regulated via a remotely controlled back-pressure valve mounted at the top of the chamber. A feedback-controlled process controller system stabilizes the chamber pressure to better than 1-percent accuracy for any given set point. For optical access, the burner rig has four ultraviolet-grade fused-silica windows with 44-mm-thick by 85-mm clear apertures located around the periphery of the flame zone. A burst disk (set at 935 psig) placed between the pressure chamber and facility exhaust pipe prevents overpressure conditions.



Photograph of a 20-atm hydrogen-air flame produced by the microtube burner in the HPGB facility operating at an equivalence ratio of 1.4. The diameter of the burner active region is approximately 0.75 in.

The specially designed microtube array burner is mounted inside the air-cooled high-temperature liner casing within the rig. This photograph shows the flame produced by the microtube burner at a pressure of 20 atm and an equivalence ratio of 1.4. The burner was designed to provide a uniform combustion product zone downstream of the flame for calibrating the laser Raman diagnostic system. The oxidizer air and the hydrogen fuel are provided by 12-pack cylinder arrays at a nominal pressure of 150 atm. The flow rates of the air and fuel can be precisely controlled with better than 0.5-percent accuracy using sonic venturi flowmeters in conjunction with computer-operated pressure regulators and valves. The flows can be adjusted to vary the flame's equivalence ratio ϕ from about 0.3 (very fuel-lean) to 4 (fuel-rich), providing a wide span of combustion products in the flame zone for optical diagnostics calibration. The maximum fuel flow rate is limited by the cooling capacity of the facility (400 000 Btu/hr). For the current series of experiments, only hydrogen-air mixtures are required; however, the facility is designed to accommodate different fuels and oxidizers including carbon monoxide, methane, oxygen-argon, and pure oxygen. All aspects of the facility operation, including startup, shutdown, and automatic safety shutdowns are controlled and monitored via an icon-based touch-screen software system and a programmable logic controller in conjunction with a cost-effective four-PC server cluster.

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