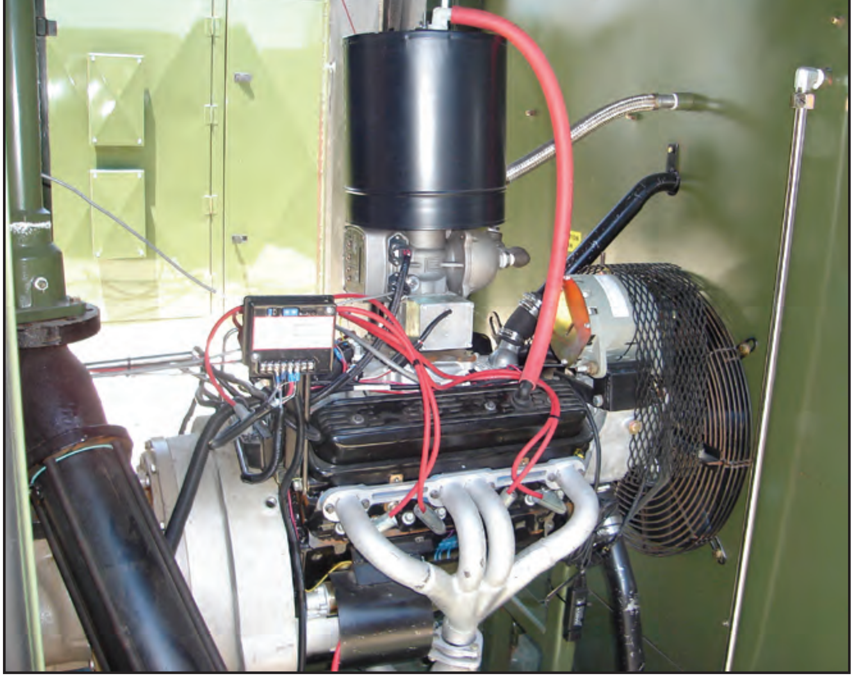

■ The EGC 2 is mounted on a Red River Compression GM 454 gas engine package.

NEW ELECTRONIC GAS CARBURETORS FROM CCC TARGET EMISSIONS AND FUEL EFFICIENCY

The Carburetors are Designed for Small Gas Engines Ranging from 50 to 500 hp (37 to 372 kW)

By Ellen Hopkins

Two new models of electronic gas carburetors from Continental Controls Corp. (CCC) target operators' needs to meet emission requirements and increase fuel efficiency while reducing engine maintenance. The carburetors are designed for small gas engines ranging from 50 to 500 hp (37 to 372 kW).

According to the company, the key to the carburetors' approach is threefold: 1. Integrated into the carburetor's electronics is a controller to support a wide-band oxygen sensor located in the engine's exhaust stream, which provides stable and reliable feedback to the carburetor for air/fuel ratio control. 2. Integration of an advanced solenoid actuated fuel valve, which operates on a patented variable pressure control concept with the pressure control setpointed based on the input from the wide-band oxygen sensor. 3. Utilization of a mixing venturi that replaces the traditional diaphragm/spring combination normally used in carburetors. The venturi also provides mixing of air and fuel, which allows the engine to run leaner before reaching a lean misfire condition.

Manufactured by CCC in San Diego, California, U.S.A., these electronic gas carburetors (EGCs) are applicable in varied modes from rich burn or stoichiometric, and can be used in conjunction with a three-way catalytic converter to lean-burn applications, which may not require any exhaust aftertreatment. In either mode, the electronic EGC 2 and EGC 4 model carburetors quickly react to all changes in operating parameters including changes in heating value or load changes. Both models have optional electronic governors, which drive a third-party actuator or electronic throttle body to control engine speed.

The EGC 2 model is designed for gas engines up to about 250 hp (186 kW). The EGC 4 will work on engines from 250 hp (186 kW) up to about 500 hp (372 kW), and up to approximately 1000 hp (745 hp) with dual EGC 4s.

Rick Fisher, Continental Controls vice president, said the carburetors are currently in use on many gas engine applications including gas compressor units, power generation and agricultural pumps. He cited extensive testing conducted by various groups — one of which was Texas A & M University AgriLife Extension Service. Varying tests on a lean-burn agricultural pump application near Amarillo, Texas, attempted to run as close to 80 hp (59 kW) as possible because that was the required load at that wellhead. The overall engine efficiency after adding the EGC 2 carburetor increased from 21.53 to 25.54. In addition, overall fuel savings amounted to 195 cu.ft. (5.5 m^3) per hour or about US$187 per hour.

Another third-party test was conducted by Sempra (the gas company of Southern California). This testing was done to allow for the EGC 2 and EGC 4 to be qualified under their Business Energy Efficiency Program (BEEP). In order to qualify for this program the EGC had to be tested to ensure fuel savings on gas engines. Sempra tested on agricultural pumps being driven by a GM 454 gas engine and a Cummins G855 gas engine. On both engines the testing showed a savings on fuel of about 8% by running in a lean-burn mode and while meeting San Joaquin Valley APCD emissions requirements.

"It's not unusual to realize significant fuel savings and other benefits such as lower exhaust temperatures, reduced maintenance and extended engine life from a lean-burn operation, which we define as an engine running greater

■ The EGC 4 is mounted on a Cummins G 855 Agricultural Pump in Tulare, California, U.S.A.

■ The EGC 4 is mounted on a Caterpillar 3408 gas compressor in India.

than 4% oxygen in the exhaust," said Fisher. "What is unusual, though, and maybe even unprecedented, is being able to achieve emissions compliance without any additional exhaust aftertreatment. By adding the EGC 2 or EGC 4, we are able to run easily at 7% or 8% oxygen in the exhaust, where previously the leanest that could possibly have been run with a traditional carburetor might be closer to 4 to 5%."

In rich-burn mode, Fisher said, and when combined with a three-way catalyst, the carburetors can maintain emissions below 0.1 g/hphr. The lower the level of desired emissions, the more critical fast and accurate air/fuel ratio control becomes.

Operating an engine under lean combustion conditions, he explained, excess air is available for combustion. This excess air passes through the engine and carries heat away such that combustion takes places at a cooler temperature.

"NO_x is formed as a function of high combustion temperature, and by reducing the temperature of the flame and the resulting gas temperature in the cylinders, NO_x is dramatically reduced," Fisher explained.

If the heating value of the fuel changes while the engine is running under the control of the oxygen sensor, the EGC will automatically adjust the fuel injection pressure into the mixing venturi to maintain the desired mixture and low emissions.

Fisher described the EGC as consisting of two main components: a venturi mixer and an electronic pressure regulator, which work together to provide precise control of the air/fuel ratio. The wide band oxygen sensor located in the engine's exhaust stream maintains the desired air/fuel ratio, he said. The EGC's variable pressure control technique is already covered under a CCC patent, and other patents are pending for the carburetor design.

The result of this control is that when air flows through the venturi mixer — the throat of which is used to draw fuel through the injection ports and into the air stream — a lower pressure is developed in the throat, resulting in the correct air/fuel ratio for operation. This air/fuel mixture is then trimmed by adjusting the setpoint of the electronic pressure regulator based on the oxygen content in the exhaust.

Other air/fuel ratio control systems work on different principles. One competing model, for example, controls the pressure of the fuel gas injected into an existing carburetor with a traditional pressure regulator and a stepper motor to restrict the fuel to the carburetor. This system relies on the oxygen sensor to alert the controller when there is a reduction in load or an increase in heating value of the gas. A signal is then sent to the stepper motor to restrict fuel to the carburetor. A transit period is required for the exhaust gas to travel through the engine, and the exhaust system to get to the oxygen sensor. This causes a delay in the oxygen feedback control signal and can result in the engine running out of compliance in an upset condition for quite some time.

Another competing type of air/fuel ratio control system has a small bypass valve that is used to add a small amount of fuel to supplement the main fuel flow. In this system, the pressure regulator is fixed in a constant pressure and the electronic control system adds fuel to the carburetor air inlet to make the mixture richer. This small valve is modulated to maintain the correct mixture. This kind of system has the same problem as the previously described model along with the additional problem of running out of the adjustment range. Transient and load conditions cause the engine to run out of compliance.

Conversely, Continental Controls' two EGC models maintain the gas injection pressure near zero for all conditions, so load changes do not require a resetting of the pressure control. Therefore, the engine does not go out of compliance during a load transient, or if the pressure setpoint does need a slight adjustment it will come right back in when the oxygen sensor feedback signal indicates the error.

Fisher said the EGC can be configured and monitored via serial communications and a personal computer. Valve Viewer provides a graphical user interface to adjust and record variables and setpoints including the oxygen sensor setpoint and default pressure control as well as all tunable, in the EGC. This configuration software is also excellent for data logging the feedback from the oxygen sensor, pressure transducer and the integrated electrical actuator.

Fisher added that the emissions limits set by government agencies can vary widely depending on state and county. The EGC display can be configured to meet most local air board requirements such as monitoring pre- and post-catalyst temperature, displaying a visual and/or audible alarm for upset condition, and monitoring oxygen setpoint and feedback, variable setpoint based on load signal, and control pressure.

"The EGC will provide the best available control technology [BACT] when used in conjunction with a properly sized three-way catalytic converter, and meet even the most stringent emissions requirements anywhere." ■

■ David Campbell of CCC sets up the EGC 2 on a GM 5.7 L gas engine.