FOR RICH BURN ENGINES

CONTINENTAL CONTROLS CORPORATION

Emissions Control System ECV5 Patent Pending

ISO 9001 Certified

Air-Fuel Ratio Control For Gas Engines

EMISSIONS REQUIREMENTS

The emissions limits set by government agencies are quite different, depending on the country and the location within a country. The current emissions limits for natural gas engines in the Southern California Coastal regions per horsepower hour are 0.15 grams of NOx, 0.6 grams of CO, and 0.6 grams of HC. Other areas around the United States have adopted or are planning to use these same low levels for their standards. These requirements can be met with rich burn engines operating a closely controlled fuel/air mixture and a catalytic converter.

CONTINENTAL CONTROLS SOLUTION

Continental Controls offers a complete system that will maintain the emissions levels of your rich burn engines in compliance with the most severe county, state, and federal emissions regulations, while maintaining peak operating efficiency.

To achieve these low levels of emissions, the ECV5 control maintains a very precise mixture of the fuel and air under a variety of ambient and load conditions. An O_2 sensor, located in the engine exhaust, is used to trim the air fuel ratio to maintain an extremely precise mixture.

The control can be supplied as a kit ready for field installation, as shown below, or simply as an ECV5 valve and O_2 sensor.

ECV 5 with TCA 75 Display and typical install kit.

MAINTAINS EMISSIONS COMPLIANCE EVEN WITH CHANGES IN SPEED AND LOAD

WIDE RANGE LOAD CONTROL

MEETS TOMORROW'S EMISSION STANDARDS TODAY

FULL AUTHORITY

FULLY AUTOMATIC

INSTALLATION KIT

MOD BUS COMMUNICATION

OPTIONAL DISPLAY

CATALYST TEMPERATURE MONITORING

HANDLES CHANGES IN GAS BTU

MAXIMIZE CONTROL

HOW THE SYSTEM WORKS

The functional diagram below is used to explain the operation of the ECV5 and the system.The ECV5 is an electronically controlled valve that functions as a zero droop pressure regulator. A precise low pressure transducer is imbedded in the valve and is used to sense the discharge pressure,which is the gas injection pressure to the carburetor or mixing device.

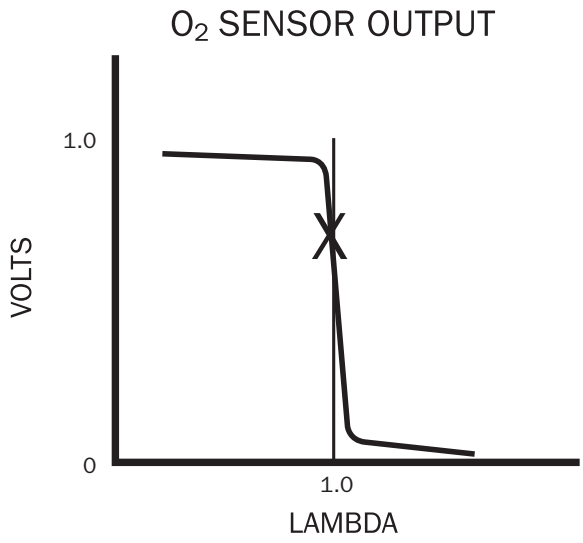
CLOSED LOOP PRESSURE CONTROL

The discharge pressure is compared to the pressure set point as shown in the diagram below. The proportional and integral control provide a fast responding, no-droop pressure regulator. The pressure set point is the default pressure and is selected to run the engine when the O_2 sensor is not operating.

ZIRCONIUM OXIDE OXYGEN SENSOR

The oxygen sensor is located in the exhaust stream before the catalytic converter; it provides a measure of the oxygen content in the exhaust. After a short warm-up period, the sensor generates a voltage in the range of 100 to 900 mv (millivolts). The O_2 sensor characteristics are shown above and to the right. If the voltage is less than 500 mv, the mixture is lean, meaning there is excess oxygen in the exhaust. The high end of the scale, near one volt, indicates the mixture is rich, which means there is very little oxygen present in the exhaust.

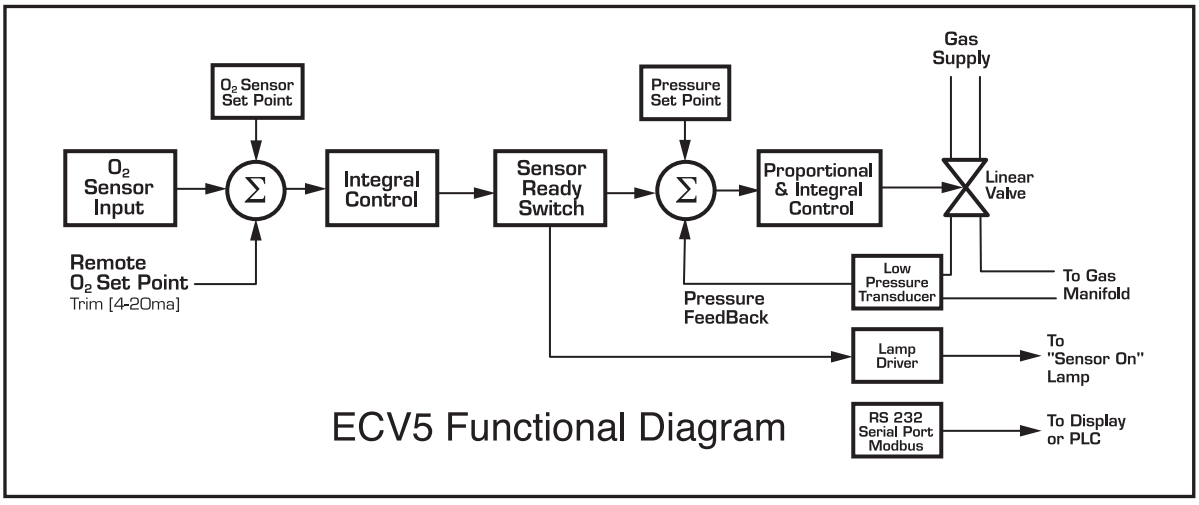
The vertical line at Lambda (equals one), which is the stoichiometric mixture and the operating region for rich burn, engines is just to the left of the line. The voltage from the O_2 sensor is compared to its



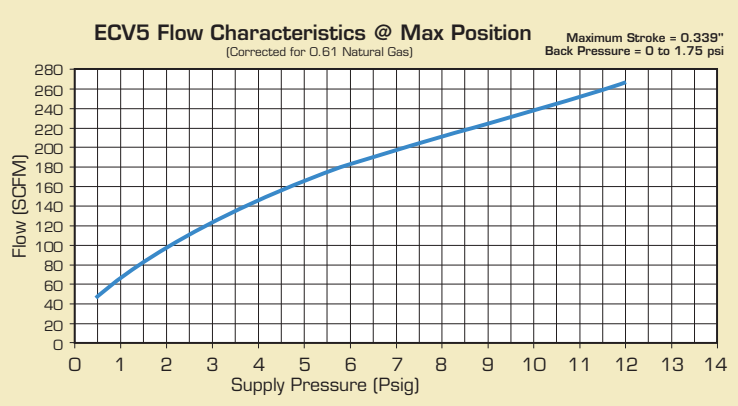
set point. The difference or error signal is the input to an integral controller and used to trim the pressure regulator set point. For natural gas fuel, the O_2 set point is normally above 500 mv, which is on the rich side of stoichiometric. The ideal gas injection pressure is found with the use of an exhaust analyzer sensing the NOx and CO in the exhaust after the catalytic converter.

GAS SUPPLY PRESSURE

The required minimum gas supply pressure is the sum of the gas injection pressure and the pressure drop across the valve. The valve pressure drop is a function of the flow through the valve and is shown in the diagram in the next column. The supply pressure does not need to be closely regulated but should be more than on the chart for the maximum flow and should not be more than 20 psi higher.



ECV5 Functional Diagram



As can be seen from the chart, if the injection pressure is zero and the gas flow is 60 scfm, 1 psi of of gas pressure is required.

TURBOCHARGED ENGINES

The fuel system of engines turbocharged after the carburetor will be connected like the naturally aspirated engines. When the turbocharger is before the carburetor, a reference line must be connected from the air inlet of the carburetor to the reference port on the ECV5.

DUAL BANK ENGINES

Dual bank engines with a single point of fuel injection and a single turbocharger are connected like a single bank engine. A dual bank engine with a turbocharger for each bank and an O_2 sensor on each bank will require an ECV5 primary on one side and an EVC5 secondary on the other side of the engine. Each will be connected with its own O_2 sensor.

LOAD TRANSIENTS RESPONSE

The valve is very fast and will transition from open to closed in less than 50ms. This will result in a very fast responding pressure regulator. If a load transient occurs, the fuel flow will change and the valve will adjust its position almost instantly and change to minimize the effect of the transient. The engine will run through the transient without falling out of compliance.

REDUCED EMISSIONS

Since the ECV5 eliminates much of the lag in the response of the fuel system, the control loop gain can be higher, which will control the O_2 sensor voltage very close to its set point. The ECV5 can maintain the oxygen content in the exhaust very close to the sweet spot of the catalytic converter with very little deviation. This results in lower NOx and CO in the exhaust. Since the mixture is not continuously varying around the operating point, or during load transients, the emissions levels are generally lower than with competitive systems.

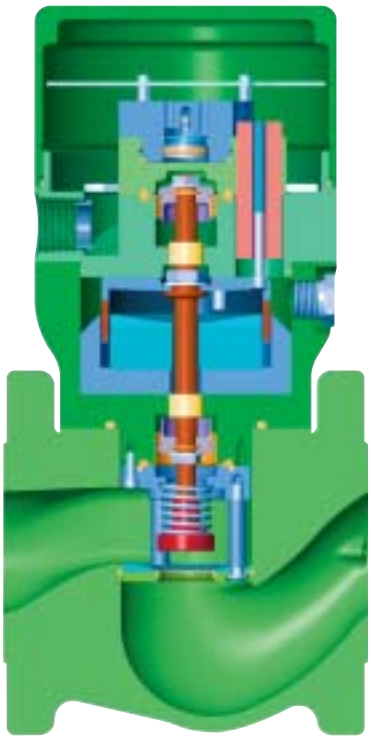
DESCRIPTION OF THE ECV5

The ECV5 is an electronically controlled servo valve. The electronic assembly is located inside the cover and includes an embedded microcomputer. The main components of the valve include: the poppet valve, the voice coil actuator, the LVDT for position feedback, and the pressure transducer.

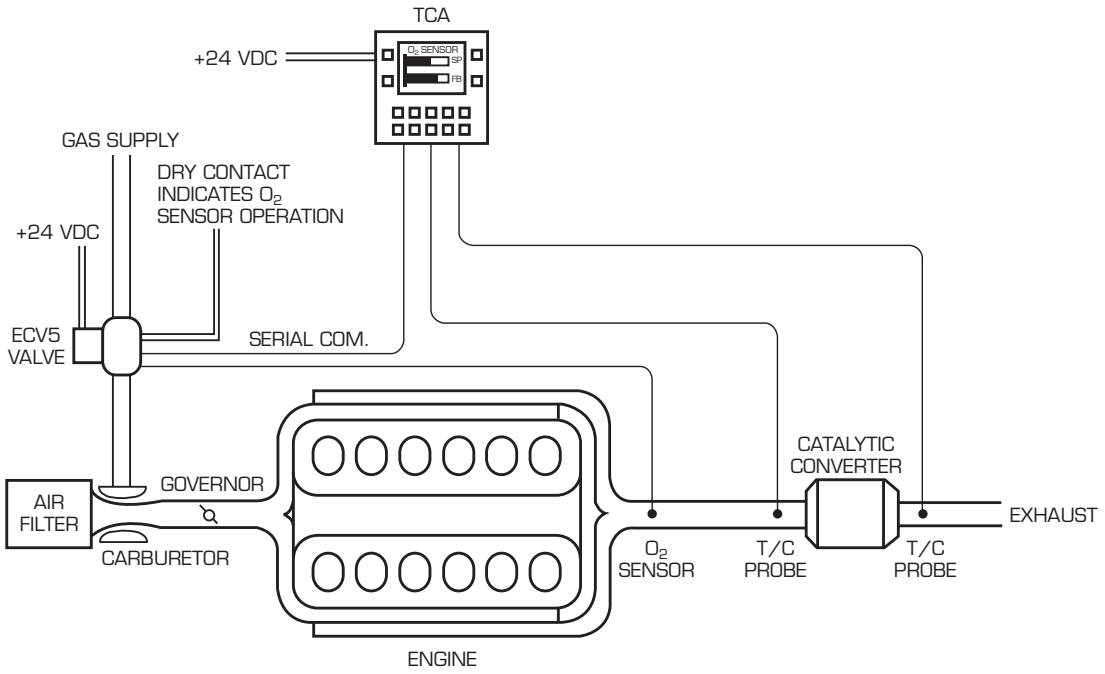
The valve has two control loops that are closed with feedback. The inner loop is the position control with the LVDT providing the position feedback signal. This inner loop gives the valve unusually fast response.

The outer loop is the pressure control with the pressure transducer providing the feedback signal. The pressure control amplifier is proportional and integral, which is required to operate the valve without droop, meaning the pressure does not change when the gas flow changes.

The valve is nearly all aluminum, except for the magnetic steel parts and the stainless steel shaft.



DESIGN FEATURES



USER INTERFACE (DISPLAY & CONTROL)

The TCA Control Unit provides the user interface with the system. It also monitors the operation of the system and displays all data available. The TCA also provides the means for changing the set points for the starting pressure and certain control set points and selected parameters. Some of the adjustments are not available by the TCA without password authorization. The TCA includes graphic display in the form of bar graphs with numeric values. The operation of the system is monitored by selecting one of the following parameters to be displayed:

- Gas injection pressure and its set point
- Oxygen sensor voltage and its set point
- Valve position
- Default pressure
- Pre and post catalyst temperature

The TCA is a miniature PLC and is programmed to provide an over temperature alarm or shutdown to prevent damage to the catalytic converter. The TCA can be used to monitor the temperature rise in the catalyst due to the exothermic reaction. The differential temperature can be displayed, logged and exported via the serial port. The TCA also is provided with a serial port for MOD-BUS communications with other control and data logging systems.

INSTALLATION

The ECV5 system is very easy to install and simple to set up for any engine. The complete kit, including: wiring, cables, sensors and display unit, is available as an option. The figure above illustrates the wiring necessary to fully implement the system.

CATALYTIC CONVERTER

To maximize reduction of NOx, CO and HC's, the ECV 5 is used on a rich burn engine with a 3-Way Catalytic converter in the exhaust. An oxygen sensor is placed in the exhaust stream before the converter. The ECV5 valve controls the air fuel mixture to maintain very precise control of oxygen content in the exhaust at the oxygen sensor. This precise control will not only maximize the effectiveness of the catalyst which will allow the system to meet the most stringent emissions requirements, but it will also extend the life expectancy of the catalyst.

When the emission requirements are not stringent enough to currently require the use of a Catalytic Converter, the ECV 5 can be used to reduce emissions or increase engine efficiency in a stand-alone mode without a Catalyst. In this mode the operator will tune the ECV 5 for the mixture that is most important to his application.

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