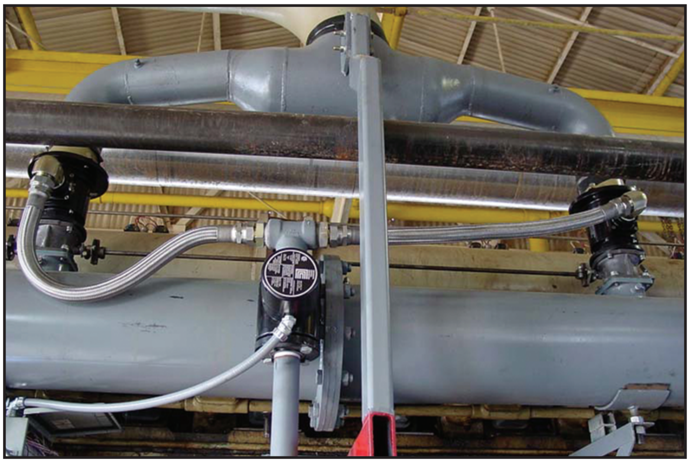
BY MIKE MERCER



Continental Control Corporation converted the fuel control systems on two Enterprise GSG-8 engines at the Coalinga, California, U.S.A., crude oil pipeline station owned by ConocoPhillips Pipe Line Co.

Air/Fuel Control Key to Engine Performance

Continental Controls' products combine to increase output and fuel efficiency while holding the line on exhaust emissions

The increased demand and cost of natural gas coupled with ever tightening exhaust emission standards presents a challenge to those who must extract the most power from their engines while using less fuel and staying within exhaust emission regulations. One company helping meet these challenges with its ECV5 emissions control valve and VM-350 mixing venturi is San Diego, California, U.S.A.-based Continental Controls Corporation (CCC).

The ECV5 is a computerized valve designed to precisely control the pressure of the fuel delivered to the mixing venturi or carburetor mixing bowl. As part of its package, the ECV5 installation kit typically includes a zirconium oxide O_2 sensor, two type K thermocouples and a computerized monitoring and display unit. When the ECV 5 and mixing venturi are used in conjunction with a three-way catalytic converter, engine emissions are reduced to a minimum.

The new VM-350 mixing venturi is designed to replace carburetors or mixing bowls and precisely mix the air and fuel admitted to the engine. This venturi also has an option to measure air flow to the engine. When used as a package with the ECV5, the VM-350 or VM-350 XL replaces the carburetor and pressure regulator on both rich-burn and lean-burn turbocharged or naturally aspirated, gaseous-fueled reciprocating engines with outputs of up to about 3000 kW depending on the fuel supply pressure.

"The ECV5 and VM-350 system bases its control on fuel pressure and then we take feedback from the O_2 sensor to readjust the pressure set-point," said Rick Fisher, of Continental Controls Corporation. "This is a more efficient approach than the typical bypass or restrictor type valve systems."

According to Fisher, with a bypass control system, the engine is set up to run lean initially, with fuel added as needed based on engine load. A restrictor valve system is set up just the opposite, and relies on a pressure regulator to control fuel pressure to the engine, then a butterfly or stepper motor is used to restrict fuel to the engine based on its load requirements. Both of these systems offer limited performance capability because they can only add or restrict fuel over a narrow range.

"The beauty of our system is that it is a 'full authority' fuel valve that can control all of the fuel to the engine all of the time," said Fisher. "The ECV5 can be used in conjunction with a carburetor, but to control the fuel in that set-up, the ECV5 has to chase the profile up and down a wider scale. It can do it, but it is more difficult. In addition, a carburetor is not the most efficient method to mix air and fuel."

These obstacles are eliminated when the VM-350 mixing venturi is used with the ECV5. "The venturi is the ultimate in air/fuel control when used with the ECV5 because it keeps the fuel pressure profile the same throughout the whole engine operation range," said Fisher. "The fuel pressure to the engine is the same regardless of engine load so we are able to set up the pressure of the unit to be right around zero. There is nothing to change; the pressure is altered within the venturi based on its design to counteract the pressure.

"The only time the fuel pressure to the venturi has to change — this is handled by the ECV5 — is if the Btu value of the fuel or the ambient air temperature changes. However, these are subtle changes by comparison to a load change on a carbureted application.

"Using the venturi and the ECV5 together really allows us to take care of

Picture of an Enterprise engine before conversion at the Coalinga, California station.

almost any application," continued Fisher. "The venturi could be used with other air/fuel ratio controllers in applications where just the carburetor is replaced by the venturi. However, the ultimate package is the ECV5 and the VM-350 venturi used together."

Just one company to successfully adapt the ECV5 and VM-350 as a package is ConocoPhillips Pipe Line Co. with five crude oil pipeline stations that have been, or are in the process of being upgraded, to solve serious engine performance issues. One station, located in Coalinga, California, was a special case. It includes three naturally aspirated, spark-ignited Enterprise GSG-8 engines rated 597 kW at 525 r/min.

Each inline, eight-cylinder engine drives a Sulzer Bingham two-stage pump through a Lufkin gearbox. The pumps now have a maximum flow rate of 120 000 barrels of oil per day and currently average about 96 000 barrels per day. Two of these engines have been converted to include an ECV5 with an O_2 sensor in the exhaust stream and ECVI display along with two Continental Controls' VM-350 venturi.

"The reason we switched to the Continental Controls fuel control set-up was to get the engines to run correctly and to get the most horsepower out of them possible," said Keith Blumert of ConocoPhilips Pipe Line. "In the past, we ran the engines and pumps at a lower pipeline throughput. However, with the increased demand for refining capacity, we needed to increase the flow on that pipeline. When we tried to step it up, the Enterprise engines detonated, especially in the hot summer months, and we were unable to get full power out of them. That was when we went looking for a solution."

Blumert contacted Continental Controls Corporation, a company he had previously worked with on similar applications in similar circumstances.

Ross Fisher of Continental Controls Corp. visited the Coalinga facility and confirmed that the engines could not carry more than about 60% of their rated load because of detonation. The evaluation showed that each engine's original intake manifolds had been modified to add a second carburetor — most likely to improve performance. The modification split the single intake manifold into two — one manifold and carburetor fed the first four cylinders while the second fed the other four cylinders.

"When the air-fuel flow through the intake manifolds was analyzed from the firing order data, the problem became obvious," said Fisher. "Without a split in the manifold, there would always be two cylinders drawing in an air/fuel mixture. However, when the manifold was split, the second manifold has no cylinders drawing fuel in the 90 to 180 degree crank angle range, the result is that the fuel-air pressure in one manifold increases to near atmospheric as the other manifold fills, permitting a larger charge of fuel to be admitted into cylinder number 7 when its intake valve opens. The same thing happens later in the other manifold where cylinder number 2 gets an excessive air-fuel charge. This causes these cylinders to detonate first, preventing further loading of the other cylinders."

To compound the problem, Fisher determined that the diameter of the intake manifold is actually less than the piston diameter and thus, the manifold had no storage capacity for the air/fuel mixture. In addition, the pressure in the manifold varies with flow since the throttle plate position does not vary on a cylinder-to-cylinder basis.

The solution was determined to include two parts. A single larger diameter intake manifold was needed and the Continental Controls ECV5 emissions control valve and twin VM-350 mixing venturi were to be installed.

The venturi each measures the volumetric air-flow and provides the throat pressure of the venturi at an external port. The throat pressures of the venturi are compared to balance the volumetric air flow when adjusting the throttle plates. A second measuring port on the venturi is the pressure of the fuel in annulus around the venturi. The pressures in the ports of the venturi are compared and balanced by adjusting the butterfly valves in the gas inlet port of the venturi.

Other modifications to the engines were the replacement of the oil bath intake air filters with dry panel-type filter elements from Spitzer, Altronic CPU 2000 ignition systems and Hilliard vacuum demisters for crankcase vapors. Additional improvements to the engines recently included cartridge style spin-on oil filters and the addition of Inconel metal exhaust valves. The valve material change allows the engines to run harder at higher temperatures. According to Blumert, the last step to improve engine efficiencies is to switch to synthetic lubricants.

"We basically wanted to get rid of the carburetors to remove restriction from the intake system to get more air through the engines and get more horsepower out of them," said Blumert. "In the process we eliminated the detonation problem and improved the fuel efficiency. The cost to upgrade these engines was less than the cost to replace them. These engines still run seven days per week, 365 days per year.

"We continue to operate under EPA restrictions for NO_x and CO," said Blumert. "We could meet these restrictions before (but only at reduced

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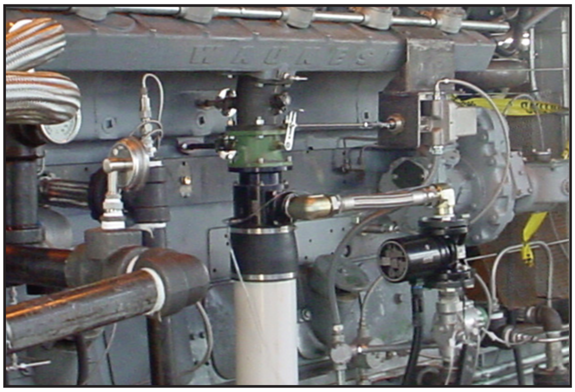

ConocoPhillips Pipe Line Co. also carried out conversions of three Waukesha 7042 engines located at its Junction pumping station. With the Continental Controls' systems they were able to eliminate the carburetors to get more usable horsepower out of the engines in the summer heat.

loads), and we are meeting them now with the switch to CCC products."

There are seven more Enterprise engines to be converted, according to Blumert, two at the Santa Margarita station near San Luis Obispo, California, two at the Torrey station near Santa Paula, California, and three at what he referred to as the Patterson station in California.

ConocoPhillips Pipe Line has also carried out conversions of three Waukesha 7042 engines located at its Junction pumping station. These Vee 12-cylinder, naturally aspirated, natural gas-fueled engines are rated 858 kW at 1200 r/min and like Coalinga are also fueled by utility supplied gas. The Waukesha engines drive three-stage pumps through Lufkin gearboxes.

These engines use a single VM-350 venturi, single ECV5 control and single O_2 feedback system for each cylinder bank of the V-12 engines. The air filters were also upgraded to Spitzer dry panel units.

"Although these engines did not have a detonation problem, we upgraded them for similar reasons," said Blumert. "With the Continental Controls' systems, we were able to eliminate the carburetors to get more usable horsepower out of the engines in the summer heat. That was the main reason. However, it is also good from a consistency standpoint for service."

According to Blumert, since these engines were installed over 15 years ago, they have been well maintained and have received the Waukesha Extender upgrade packages over the years that included such components as updated cylinder liners and pistons, as well as bearings, filtration and lubrication upgrades along with the Inconel exhaust valves. These engines also use Altronic ignition systems, Hilliard vacuum demisters and Johnson Matthey catalytic converters.

All of these pump stations are continuously monitored and controlled remotely from ConocoPhillips pipeline control center in Ponca City, Oklahoma, U.S.A.

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BY MIKE MERCER

MHI and Solar Sign Agreement

Mitsubishi Heavy Industries Ltd. (MHI) has signed a cooperative agreement with Solar Turbines Incorporated relating to centrifugal compressors. Under the agreement, MHI will supply its MAC (Mitsubishi Advanced Compressor) centrifugal compressors to Solar Turbines and Solar Turbines will offer packages coupling the compressors with its own gas turbines. Initially, the agreement is to apply to MHI's standard-design MAC compressors that match to Solar Turbines' gas turbines with power outputs ranging between 8 and 15 MW (models Mars 90, Mars 100 and Titan 130). Mitsubishi Corporation, acting in the role of trading company, will cooperate in the application and sales of these products.

GE Turbines in Thailand

GE Energy's oil and gas business has signed a strategic agreement with PTT Utility Company Limited (PTTUT) of Thailand for the supply of equipment and services. PTTUT is an affiliate of PTT, established to provide utilities to PTT's Petrochemical Group. PTT is Thailand's fully integrated energy company and has the largest market capitalization of all energy companies listed on the stock exchange in Thailand.

Under the new agreement, PTTUT and other affiliated companies of the PTT Group will purchase eight GE gas turbine-generator packages within the next four years, for a total value of more than US$80 million. The first gas turbine package awarded under the agreement was purchased by National Petrochemical (NPC), an affiliated petrochemical company of PTT.

TEMA Receives Private Equity Investment

Actis, a London-based private equity investor in emerging markets, has spent US$12 million to secure a stake in TEMA India Ltd., the heat exchanger manufacturer. TEMA India specializes in designing and fabricating shell and tube heat exchangers for the oil and gas, energy and chemical industries. It also makes high-pressure heat exchangers and has won contracts with EPC contractors for the oil and gas industry including Bechtel, Fluor, Technip, Uhde and Jacobs.

TEMA, has achieved revenues of US$20 million in the year ending March 2005 and the investment will help the company to establish a new facility, allowing it to fulfill larger size orders and improve manufacturing processes, enhancing margins and building overseas sales, according to the company.