Good Air/Fuel Management Helps Avert a Disaster

A precise diet of air and fuel keeps engines happy and healthy.

BY DAN RAFTER

Greg Dahl called the situation worse than a disaster, and he wasn't exaggerating. His company, Texas-based Applied LNG Technologies, recently had opened its new Wildwood Liquefier in Stockton, CA, with the simple goal of converting stranded well-waste gas from an industrial site into high-purity liquefied natural gas (LNG), a form of gas that boasts several advantages over traditional petroleum-based fuels. It seemed like an easy task; Applied LNG, after all, is the largest wholesaler of LNG in the western United States and Mexico.

Unfortunately things didn't work out as planned.

Applied LNG opened its Stockton facility in 2001. But it wasn't until spring 2003 that officials with the firm finally were able to efficiently meet the plant's goal of creating useful liquid gas from waste products largely made up of methane gas. And what was the problem that had stalled the company's success? It was a power-generation issue, one that sometimes shut down the facility for up to eight consecutive hours.

"It had gotten to the point where everyone was getting frustrated. The last thing we thought would be a problem with this plant would be power generation," admits Dahl, field operations manager for Applied LNG. "That should be a no-brainer. Everybody can run a generator, come on. But this was a very unique situation."

Fortunately for Applied LNG, Dahl and his crew eventually hooked up with San Diego, CA–based Continental Controls Corporation, a company that produces control systems and components for gas turbines and reciprocating engines. The firm's officials came up with a simple solution to a problem that had been vexing Applied LNG for nearly a year: By using a controller that provides advanced air/fuel ratio control, the Stockton facility now creates about 5,000 gal. of LNG every day while meeting the emissions requirement of the Environmental Protection Agency (EPA).

The story of how Applied LNG and Continental Controls came together to solve a problem is an important one. The use of LNG, thanks to its many benefits when compared to petroleum fuel, is expected to grow in the coming years. Success stories such as the one at Applied LNG's Stockton plant should provide an added boost to this growing industry.

"For one reason or another, this project turned out to be a really demanding application," says Rick Fisher, spokesman for Continental Controls. "Our products can help companies, such as Applied LNG, handle their easy applications. But we can also help with the hard situations. Thanks to our product, Applied LNG is able to operate their plant and meet their emissions requirements. This turned out to be a really interesting case for us."

What was the key to solving Applied LNG's problem? Those involved say it was all a matter of perseverance and finding the right tool for the job.

The Problem

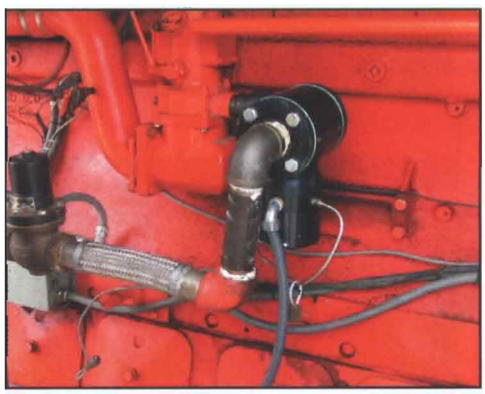
It's no surprise that the natural-gas industry is becoming more important in this country. Natural gas, after all, beats traditional petroleum-based fuels for several reasons. For example, businesses that use natural gas are protected from wildly fluctuating prices because the US has substantial domestic natural-gas reserves, making it more attractive for businesses. In addition, when natural gas is purified, its energy content is more cost-effective than the content of traditional fuels. This means that vehicles run more efficiently and with less maintenance, thanks to the clean burning of the fuel. And lastly it burns cleaner, making it easier for businesses to comply with air-pollution laws set out by EPA and state agencies.

Photo: Continental Controls

Of course, this isn't to say that natural gas will replace traditional fuel anytime soon. But there is evidence that the technology will grow steadily in popularity. During the third annual Clean Heavy-Duty Vehicles Conference held in Arizona in February 2003, for instance, a survey reported that vehicles powered by natural gas are expected to account for 10% of the heavy-duty vehicle market by 2010.

Officials with Applied LNG, of course, recognize this and have been supplying natural gas since 1995. The firm provides natural gas for municipal, industrial, and transportation uses. For instance, Applied LNG provides LNG to a paving company with contracts throughout the southwestern US. The company turned to Applied LNG because it had been facing heavy fines from the pollution caused by diesel exhaust. The paving company eliminated this problem as soon as it started relying on cleaner-burning LNG.

To create its LNG, Applied LNG condenses natural gas to a liquid state by passing it through a series of refrigeration steps that ultimately reduce its temperature to –259°F. To do this at the firm's Stockton facility, which is not connected to grid power, engineers with Applied LNG rely on a Waukesha 525-kW generator. Applied LNG workers use pipeline gas to start the engine. But over time, as the facility liquefies the site's natural gas, the process gives off significant amounts of waste gas that does not liquefy. Applied LNG diverts that gas back to the generator, providing continued power for the engine. The firm's engineers viewed this as an ideal situation, one in which no gas—not even waste gas—is wasted. For a company that helps business and municipal clients reduce their own emissions, the Stockton plant was to be an exemplary clean, efficient, and environmentally friendly facility.



Photos: Continental Controls

ECV 5 Air Fuel Controller on Waukesha VHP3500GSI at Applied LNG

Unfortunately reaching that goal was not nearly as easy as Applied LNG officials had hoped. As the Waukesha engine runs, it steadily relies more and more on waste gas until it is not relying on pipeline gas at all. This shifting from pipeline to waste gas created big problems. The reason? The pipeline gas has a fuel-heating value of 850 Btu/ft.³ As more waste fuel consisting mainly of methane and nitrogen enters the generator, however, the fuel-heating value gradually and steadily drops to about 515 Btu/ft.³

That is a drastic change. The Waukesha generator is designed to handle a wide range of Btu levels, but to allow this to happen, a person manually must change its settings. That was something that couldn't be done at the Stockton facility.

"It's not like we were switching fuels," Dahl explains. "We are not going from one fuel to another. We have to burn everything in between as we go from 850 Btu to 515 Btu. There wasn't any engine on the market that could allow us to do that. The Waukesha could go to 950 Btu and then, after you switched its carburetor, go down to 450 Btu. That's a great range. But it was something you had to do manually, and that didn't work for us."

To keep the facility running, Applied LNG workers manually would adjust the engine's pressure volume. Not only did this slow the process of creating LNG, but it was also an inexact science. Often the engine, despite everyone's efforts, hit a low Btu level and shut itself down. This was more than an inconvenience. It takes Applied LNG employees about six hours to get the plant running again after a generator shutdown. If the generator happens to quit in the middle of the night when no one is at the facility, it might take workers as long as eight hours to get operations back at full speed.

"This was a problem that really caused us some great concern," Dahl says. "None of us could really believe this was happening. We tried a lot of solutions. And we worked with a lot of people to solve this problem. We'd have minor successes here and there, but nothing really worked. We just couldn't get there."

Applied LNG initially tried to get a regulator with a bypass system to coax the generator into handling the wide range of Btu levels necessary to operate the Stockton plant. But by doing this, the generator was unable to get enough fuel pressure to power it. Applied LNG officials then switched to a regulator set with normal pressure that relied on a stepper motor that would open and close. This time the company was unable to generate a high enough fuel pressure when the generator needed to rely on low-Btu gas.

In fact, the firm wrestled with the problem for nearly a year. Fortunately company officials eventually contacted Continental Controls Corporation.

Even more fortunate is that Continental Controls offers an ECV-5 emissions control valve. This computerized valve precisely controls the fuel-injection pressure to a generator's carburetor or mixing bowl and essentially acts as an electronic pressure regulator. The computer in the valve measures the voltage from the oxygen sensor located in the engine exhaust and adjusts the pressure at the valve discharge to maintain the proper air/fuel ratio.

This little valve turned out to be the remedy to Dahl's nearly yearlong disaster. Since Applied LNG attached the ECV-5 controller to its Waukesha Enginator generator in spring 2003, the generator has been working flawlessly.

"We didn't know how we were ever going to get to a solution," Dahl says. "We thought we had been through all of the avenues we could come up with. We weren't sure we were going to be able to get to where we needed to be. We were pretty tickled to death when we found this solution. Basically we put this on, adjusted it for our facility, and went home. It's worked perfectly ever since."

The Solution

Will Hoie, a software engineer with Continental Controls Corporation, points out that the problem faced by Applied LNG was tai-

lor-made for the ECV-5 controller. "They needed a regulator with a very large range but one that could still allow them to have control over their air/fuel ratio so that they could meet their emissions requirements. That's where we came in. With our air/fuel ratio control, we have total control over the fuel. We can go from zero to whatever it needs for fuel. By having that huge range, we were able to adjust to whether the generator was using pipeline gas or not. We use an oxygen sensor to tell us whether the fuel is too lean or too rich, and the control adjusts the machine's pressure from there."

The ECV-5 system operates in a deceptively simple manner. But as Dahl will attest, the valve functions quite well. The system can be described as an electronically controlled valve that functions as a zero-droop pressure regulator. A precise low-pressure transducer is imbedded in the valve and senses the discharge pressure, which is the gas-injection pressure to the carburetor or the mixing device.

The key to the system's success—and to solving the problem at Applied LNG's Stockton facility—lies in the system's oxygen sensor. The sensor is located in an engine's exhaust stream before its catalytic converter. The sensor measures the oxygen content in the exhaust and generates a voltage in the range of 100–900 mV. If the sensor picks up a voltage of less than 500 mV, the mixture is lean, meaning that the exhaust has excess oxygen. If the mixture reaches the high end of the scale (anywhere near 1 V), it is rich, meaning that there is very little oxygen present in the exhaust. The sensor, relaying this information, essentially tells a generator what the ideal gas-injection pressure is and then automatically ensures that the machine hits this value.

The valve then becomes a fast-acting and precise pressure regulator that maintains the fuel-injection pressure even during speed and load changes. In short, it was exactly what officials with Applied LNG needed.

The ECV-5 valve doesn't look like much. But the electronic assembly located inside it is powerful and contains an embedded microcomputer. This computer is responsible for controlling the air/fuel ratio. The valve is designed for use with 100- to 1,000-hp engines, with and without turbochargers. The valve also operates very quickly, making it possible to change the fuel-injection pressure almost instantly.

In more good news, by using the ECV-5 valve, officials with Applied LNG have reduced the plant's emissions. This, according to Continental Controls's Web site, is one of the top benefits of the ECV-5 valve. The valve eliminates much of the lag in any power-generation system. The valve controls the output of the oxygen sensor directly at an engine's catalytic converter with very little deviation. This means that, with the use of an exhaust analyzer after the catalyst, engineers can control the fuel mixture so it provides the lowest amount of emissions possible. Because the fuel mixture is not continuously varying around the operating point, these emission levels are well below the current air-quality standards.

Hoie says the ECV-5 valve is becoming more popular as emissions standards across the country grow stricter and facilities, such as Applied LNG's Stockton plant, find that it can help them meet their unique needs. "In the past, the Environmental Protection Agency and state agencies would just come out and test engines at one range of operation. A generator might be tested at 500 kilowatts and that would be it. That's not the case any longer." Today regulators test engines at different load ranges. Operators then need a control that allows engines to adjust on the fly.

For Hoie, working on such problems as the one faced by the Stockton plant is what makes his job interesting. "Working on this product has been great. This is really fun. You can get out of the meeting room, go to a real site where someone is having a real problem, put your product in there, and watch as it fixes everything. Everyone's smiling when you're done. You can't beat that."

The ECV-5 valve was born when a company approached Continental Controls with a problem: It was running generators that needed to run on fuels containing a large mix of Btu levels. Continental Controls already had a fuel valve designed for fuel reciprocation on large engines. Company engineers simply adapted this valve to recognize whether engines were running on rich or lean fuel.

Today the ECV-5 valve is helping businesses across the country. For instance, a company based in Los Angeles is using the valve to power generators running on methane gas from sewage. The valve also is present in a Palm Springs, CA, resort that runs its facility on nine generators. The resort relies solely on local power and is not connected to any power grid.

"We've generally been getting everybody's worst cases to resolve," Hoie notes. "That has been somewhat of a challenge. You get these kinds of situations that are hard to foresee when you initially design a product. But that's what makes it enjoyable. At the Stockton facility, we faced a truly challenging problem. I'm just glad we were able to help."

Hoie expects more companies to request his company's ECV-5 valve as news of its successes continues to spread. "Everyone's happy in a situation like this. That's the best advertisement the valve can have."

Count Applied LNG's Dahl as a believer. "We're all relieved now," he says. "And we're very excited about this facility." DE

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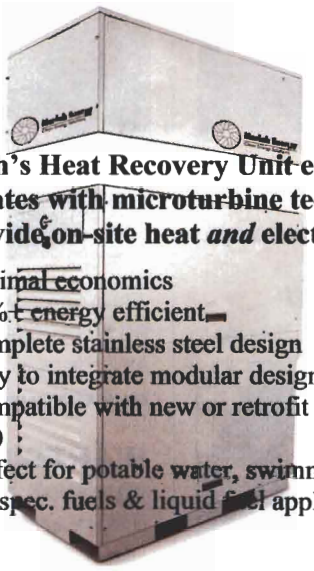

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