



Every project at Applied Compression Systems begins with a blank piece of paper. Once the customer's requirements are understood and the best equipment and processes for the project have been determined, the engineering group creates the CAD drawings. This custom-designed gas recycling and purification system uses a LeROI HG12 screw compressor in a closed-loop system to create a real-life simulation environment for testing automotive CNG fuel injectors.

GAS RECYCLING AND PURIFICATION SYSTEM FOR MAJOR AUTOMOTIVE PARTS MANUFACTURER

Applied compression develops closed-loop natural gas compression system to simulate CNG fuel injector operation

By Neil Purslow

Compressed natural gas (CNG) fuel injectors undergo rigorous testing before they are introduced to the market. Among the battery of tests that are used to prove a product is the durability test, which consists of 400 million cycles in a test environment using simulated real-life engine conditions. In 2010, automotive parts manufacturer Delphi Automotive approached Applied Compression Systems Ltd. of Cranbrook, British Columbia, Canada, wanting to use natural gas as the test medium for their durability testing.

"Delivering a continuous source

of pressurized natural gas for testing was easy, the challenge was reducing or eliminating the cost of the fuel for the ongoing operation of the testing facility," said Mike Sanderman, operations manager for Applied Compression. "The testing system requires in excess of 100 Mscf ($2.8 \times 10^3 \text{ m}^3$) of natural gas each day. Finding the right solution was important because of the potential for a substantial savings in fuel cost."

A single-pass system was eliminated because a suitable end use for the discharged gas from the testing process

could not be found. Delphi specified it wanted to recirculate the gas and use it continuously to test CNG injectors. After many discussions, a solution was determined by Applied Compression, which then designed and fabricated a closed-loop gas recycling and purification system to meet the objectives of the project.

"Since the compressor package was critical to our testing process, it had to meet very specific operating criteria," said Raul Bircann, senior project engineer for Delphi's Powertrain Division. "In addition to



Since the compressor package is located at Delphi Automotive's research facility near a residential area in upstate New York, U.S.A., it had to be attractive once assembled. It also needed to be suitable for operating in winter, which meant that heaters and insulation were required. A stainless-steel enclosure mounted on the outside of the building houses all of the electrical equipment required to start and run the motor.

the compressor being safe, reliable and as emission-free as possible, the package had to be attractive because it would be located at our research facility near a residential area. It also had to be suitable for operating in upstate New York [U.S.A.] winters."

The system is designed to take natural gas from the local gas utility company and deliver it into the testing system. Once the system is fully charged, automatic control valves isolate the feed gas inlet. The gas pressure is boosted to 125 psig (8.6 bar), filtered and dehydrated to a dewpoint of -40°F (-40°C), before being piped to the testing facility. In the test facility, high-cycle testing of the automotive CNG injectors is completed

using the compressed natural gas. Different qualities of gas are simulated during the testing to represent the actual conditions that will be encountered in the field, such as entraining oil in the gas to represent oil carryover from some screw and older reciprocating compressors.

After the testing cycle for the injectors is finished, the gas passes into a collection manifold, where it is directed to an expansion tank. The tank expands the gas to a pressure of 5 psig (0.3 bar), which is intended to simulate the operation of injectors where fuel is discharged close to atmospheric pressure in an engine. From the expansion tank, the gas is delivered to the compressor, where it



On this LeROI screw compressor package, the electric motor is directly coupled to the compressor. The vessel on the right side of the picture is a free-water knockout drum. The gas is filtered and dried after it is compressed because removing the water from compressed gas is easier than removing it from gas that is at atmospheric pressure.

is recompressed and returned to the test facility to be reused.

"The end result was a closed-loop system that runs all the time with minimal gas loss," said Sanderman. "A substantial savings in operating cost was realized because the cost of gas is reduced to near zero after the initial charge of the system, and the need to vent gas was eliminated to address environmental concerns. Even the natural gas that is used to regenerate the gas dryers is recovered and fed to the suction side of the compressor."

The compressor package includes a LeROI HG12 screw compressor that is rated at 125 hp (93 kW). The compressor is driven by an electric motor, with all the required switchgear, starters and contactors housed in a stainless-steel enclosure mounted on the outside of the building. Also included are an oil cooler and a gas aftercooler to remove the heat of compression from the discharged gas.

The package is controlled by a PLC control panel that monitors and adjusts the equipment and processes to maintain production throughput. An HMI touchscreen on the compressor control panel makes the adjustment of setpoints easy and provides alarm and event history with first-out diagnostics. Included in the package is a twin-tower self-regenerating gas dryer. When one tower is dehydrating the gas stream to the testing facility, the other regenerates itself by having a slipstream of compressed gas flow over the desiccant bed to remove the water. The towers change functions on a fixed time cycle.

Other equipment on the skid includes a free-water knockout drum, filtration system, automated control valves, gas detection system and two expansion tanks that are used as a buffer to help manage the inlet gas stream to the compressor. The main expansion tank is located outside the compressor building. All the equipment is housed in an insulated and heated self-framed metal building.

Prior to shipping the completed package to New York, the unit was test run and load tested with air at Applied Compression's Cranbrook facility. Representatives from Delphi collaborated in the testing, and helped replicate the actual operating conditions the package would encounter at their testing facility.

After the unit was delivered and installed in the testing facility, Applied Compression performed the on-site commissioning. When highly instrumented packages are commissioned, it is beneficial for the company's personnel to be on-site to adjust the operation



Included in the package for Delphi Automotive is a twin-tower self-regenerating gas dryer. When one tower is being used to dehydrate the gas stream to the testing facility, the other tower is regenerating itself by having a slipstream of compressed gas flow over the desiccant bed to remove the water. The towers change functions on a fixed time cycle. The saturated natural gas is fed into the suction side of the compressor.

of the package. Such items as control sequences are nearly always different on-site than what was envisioned when the PLCs were programmed.

“This application was an ideal fit for us,” said Sanderman. “Our focus is on building custom-designed compression systems for specialized applica-

tions in the oil and gas, petrochemical, waste-to-energy, research, alternative fuel and power generation industries. Using a gas recycling system to reduce the cost of consumed gas can easily be adapted to other applications.”

Applied Compression offers a full range of innovative compressor pack-

age solutions, including fuel gas boosters, small specialized process gas compressor packages, nitrogen generators and gas boosters, vapor recovery units, boil-off gas compressors, and instrument and starting air compressor packages. The company uses about 25 to 30 different brands of products on its packages. The company’s goal is to find the product that best suits the application without being modified, which means it must carry a large variety of products to meet this objective.

Many of these systems are offered in a fully assembled containerized version, which allows the container to be used as a weatherproof enclosure after the package is on-site. Given the current 4000 sq.ft. (370 m²) of assembly space and the overhead lifting capacity, only packages up to 500 hp (373 kW) can be assembled.

“We are a relatively small company, so these specialized niche markets play an important role in our success,” said Sanderman. “Much of the equipment we build is exported. We have recently completed projects in Venezuela, Bolivia, Mexico and Saudi Arabia, and are currently working on packages for Israel and Australia.” ©

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