Basic Systems Inc. designed the expansion of this gas storage facility in remote north central Pennsylvania, U.S.A. Six Capstone C65 microturbines were initially installed to provide the additional power required for the expansion.

MICROTURBINES POWER REMOTE APPALACHIAN COMPRESSOR STATIONS

Basic Systems Inc. Designs Independent Electrical Systems for Gas Pipeline, Storage Facilities

By Norm Shade

The fast growth of the Marcellus Shale and other natural gas plays in the Appalachian Basin is creating the need for rapid expansion of the supporting infrastructure in the northeastern United States.

Existing compressor stations used for central gathering, processing, pipeline transmission and storage/withdrawal are being expanded and new ones are being developed. One of the challenges with many of the proposed expansions is that the electrical power infrastructure does not adequately serve much of the rugged Appalachian foothills and mountain regions of Pennsylvania and West Virginia, U.S.A., and neighboring states. Many areas are prone to blackouts and there is insufficient electric power for expansion.

Increasingly, microturbines are being used to provide the electric power for natural gas compressor stations. "In the last five years, we have designed a number of stations that use Capstone microturbines for power generation," said Jean Roe, senior project manager for Basic Systems Inc. of Cambridge, Ohio, U.S.A.

"We recently finished a major expansion of a natural gas storage facility in a remote region of north central Pennsylvania," said Ron Stiger, electrical engineer for Basic Systems. "The outside utility service for the station is limited to 500 kW [671 hp], and the installation of natural gas-fueled microturbines avoided the expense of running large electrical lines for the additional electrical power required for expansion. The microturbines also make the station self-sufficient for electrical power."

The fully functional station previously had five 1300 hp (969 kW) Clark HBA-5T and two 2000 hp (1491 kW) Clark TLA-6 integral engine compressors, a dehydration plant, gas metering and a full complement of ancillary equipment. It had been used primarily as a storage facility with limited transmission (relay) capabilities. The expansion included the installation of a new 2370 hp (1767 kW) Caterpillar G3608 package with an Ariel JGU/4 reciprocating compressor, a refurbished 5800 hp (4325 kW) Solar Centaur 50 gas turbine package with a Solar C337 centrifugal compressor, an additional 100 MMscfd (2.83 x 10^6 Nm^3/d) of dehydration capacity, and a new out-of-storage separator.

Additional equipment and piping were also necessary for the incremental units, with electrical feeds and controls to make them an integral part of the station and its operation. The expansion resulted in the capability to reduce the discharge pressure on withdrawal from 1000 to 800 psig (68.9 to 55.2 bar) and increased the last day withdrawal from the storage field by 78 MMscfd (2.21 x 10^6 Nm^3/d) to 391 MMscfd (11.1 x 10^6 Nm^3/d).

To accommodate the additional equipment, new turbine compressor, gas control and reciprocating compressor

continued on page 50

Electric power was not economically available at this greenfield natural gas storage facility in West Virginia, U.S.A. Basic Systems Inc.'s design included four Caterpillar G3608/Ariel JGC/6 compressor packages. Nine Capstone model C65 microturbines provide all the power for the site.

buildings were added at the site and the existing motor control center (MCC) building and warehouse were expanded. A new building was constructed for the microturbines. Stiger said, "Six microturbines were initially installed, but the building and electrical system were sized for eight to provide for future needs. These two additional units have since been installed and were commissioned in December 2010."

The nominal electrical power output of each Capstone C65 microturbine unit before derating is 87 hp (65 kW). At the site conditions of 122°F (50°C) and 1600 ft. (487.7 m), each can produce 66 hp (49 kW), burning clean, dry pipeline gas. The units provide 127 Amps of maximum current output for standalone operation and 100 Amps for grid connect operation at a three-phase voltage of 400 to 480 Vac.

"Another site in a very remote part of West Virginia has a total of nine microturbines," Roe said. "It was a greenfield facility in mountainous terrain where electric power was not economically available, so all the site power is generated by the Capstone microturbines. The station was built in two phases to add injection and withdrawal capacity to an existing storage field. Basic Systems handled engineering, drafting, equipment and building specifications, bid review and recommendations, material requisitions and construction contract documents. Our scope included a site design for the compressor station and access road, compressor building, auxiliary/office building, utility building, chromatographs building, dekatherm building and drum storage building," Roe said.

The first phase in 2005 included two 1775 hp (1324 kW) Caterpillar G3608TALE natural gas engines driving Ariel JGC/6 compressors, each with three first-stage and two second-stage cylinders. The installation included a glycol dehydration system, gas measurement system and all necessary auxiliary equipment including main gas inlet filter-separators, interstage separators, discharge filter-separators, gas and engine coolant systems including aerial coolers, storage tanks for hydrocarbons, lube oil supply and drain, coolant and triethylene glycol handling, gas chromatographs and moisture analyzers, fuel gas system, utility gas system, starting and instrument air systems, hot water heating system, emergency shutdown system, fire and gas detection system, prime power generation, uninterruptible power supply, MCC and variable frequency drive for the station. The second phase added two more of the Caterpillar engine, Ariel compressor packages in 2007.

Four of the nine Capstone microturbines were equipped with waste heat recovery exchangers to provide building heat during the winter. Seven were installed in the first phase and two more were added in 2007.

"In the fall of 2009, yet another of our greenfield station designs went into service in a remote part of Pennsylvania. With two Caterpillar G3608 driven compressor packages, the site has no outside electric utility and is supported solely by six microturbines with space for two more if needed for expansion," Roe said.

"Capstone microturbines have proven to be a reliable source of electric power for remote compressor stations," said Jim Bondi, director of applications engineering for E-Finity Distributed Generation LLC, Capstone's Mid-Atlantic distributor. "Our largest customer in the region currently has a fleet of 48 microturbines, which together are capable of producing more than 3 MW of on-site electricity at 10 compressor station sites throughout the eastern United States. We provide 24/7 remote monitoring and complete all service and maintenance on the units through an all-inclusive fixed-rate factory protection plan," Bondi said.

continued on page 52

Four of nine compact Capstone C65-ICHP microturbines with exhaust heat recovery, shown in a facility designed by Basic Systems Inc. The nine microturbines provide all of the electrical power for a new compressor station at a remote gas storage site.

Capstone indicates that with one moving part and a direct-connected magnetic generator, there is minimal maintenance and downtime. The patented air bearings require no lubrication or coolant. The self-contained UL-certified system includes remote monitoring and diagnostic capabilities, integrated utility synchronization and protection. "The small, modular design allows for easy, low-cost installation. Reliability is proven with tens of millions of run hours and counting," said Bondi.

Capstone said its microturbines operate on natural gas with HHV ranging from 825 to 1275 Btu/scf (30.7 to 47.5 MT/m^3) at a gas inlet pressure of 75 to 80 psig (5.2 to 5.5 bar). The specified heat rate for the model C65 is 11,800 Btu/kWh (12.4 MJ/kWh) with NO_x emissions of 0.16 g/bhp-hr (0.46 lb./MWhe) at 1% O_2 with an exhaust temperature of 588°F (309°C).

The medium size of three standard Capstone microturbine frames, the C65 package measures 30 in. x 77 in. x 76 in. (76 cm x 196 cm x 193 cm). The grid connect model weighs 1671 lb. (758 kg), and the dual mode (grid or standalone) model weighs 2471 lb. (1121 kg). The standard C65-ICHP package with exhaust heat recovery measures 30 in. x 87 in. x 93 in. (76 cm x 221 cm x 236 cm) and adds 529 lb. (242 kg) to the weight of the basic unit. Specified noise emissions at full-load power measured at 33 ft. (10 m) are 70 dBA for the C65 and 65 dBA for the C65-ICHP.

The C65-ICHP unit's integrated heat recovery module provides 251,000 Btu/hr (74 kW) of hot water recovery using a stainless-steel core or 408,000 Btu/hr (120 kW) using a copper core, resulting in total system efficiencies of 62% and 82%, respectively, or higher. A 50/50 water/glycol mix is typically used in the heat recovery system. At the compressor stations, recovered heat, which would otherwise be lost to the atmosphere via a radiator, is used for building heating, eliminating the need for separate gas-fired boilers. The heat is also used to warm fuel gas, chilled during the decompression process, from 35°F (1.7°C) to 85°F (29.4°C) for the large gas turbine compressor drivers.

"The microturbines avoid the cost of expanding the electrical grid and allow the stations to be self-sufficient. Lead time for obtaining electrical power is reduced to three months instead of the much longer and complex time of negotiating with the electrical company and right-of-way owners and waiting on the construction of power lines," explained Stiger. "Basic Systems has the unique competencies to do these kinds of comprehensive compressor station projects," said Roe.

Recent Orders

Rolls-Royce Reports Multiple Orders

Rolls-Royce has won new contracts valued at more than US$110 million for energy projects in Europe, Africa, India and the Middle East. As part of these contracts, Rolls-Royce will deliver both power generation and pipeline transmission products and services.

Total Oil Co. has ordered two RB211 gas turbine power generation packages to provide power to an oil facility in the Middle East. The units will use gas fuel that would otherwise have been burned off, Rolls-Royce said. Two additional RB211 packages will be supplied to Slovenský plynárenský priemysel, a.s. (SPP) for use in a compressor station, which is part of the gas transmission network in Central Europe. Rolls-Royce has already provided five turbines to the gas transmission system, which last year enabled the network to deliver 2.3 Tcf (66 x 10^9 m^3) of gas to homes and businesses.

Rolls-Royce will also provide Bergen reciprocating engines to customers in Tanzania, Madagascar, India and Spain for electrical generation.

Howden Receives Multimillion-Pound Order in Australia

Howden Compressors Ltd. has received a multimillion-Pound order to manufacture and supply several of its largest screw compressors, over a two-year period, for a coalbed methane, liquefied natural gas (LNG) project in Queensland, Australia.

Large-capacity Howden screw compressors will be installed in compression systems for BG Group plc's Queensland Curtis LNG project. The systems will assist in gathering and compressing coalbed methane gas reserves located inland, along with reserves 984 to 1970 ft. (300 to 600 m) underground. The gas will be fed through transmission pipelines to a liquefied natural gas plant being developed near Gladstone, on the coast of Queensland.

Howden Compressors also said it has recruited additional engineering staff at its Glasgow factory in Scotland, increasing the total headcount at the site by 30%.

Aker Solutions, Statoil Sign Subsea Gas Compression Contract

Aker Solutions recently signed a subsea gas compression contract with Statoil for a compressor system project in Åsgard, located near Haltenbanken, Norway, offshore in water depths varying from 787 to 1020 ft. (240 to 310 m).

Aker Solutions' scope of supply for the subsea compression system includes a subsea compressor manifold station (SCMS), subsea compressor station, template structure, three identical compressor trains, all electrical control systems, a high-voltage electrical power distribution system, topside equipment, tooling, transportation and equipment installation, Aker Solutions said.

The project will be managed out of Aker Solutions' headquarters in Oslo, Norway, while the equipment will be manufactured primarily at the company's facilities in Egersund, and Tranby, Norway, and in Aberdeen, Scotland.

Final equipment deliveries will be made in stages with the SCMS and the compressor station template structure delivered in 2013 and the compressor trains, controls and power equipment delivered in 2014.

Burckhardt Compression Completes Test of Laby-GI Compressor

Burckhardt Compression successfully completed the mechanical test run of the Laby-GI compressor on Golar's floating storage and regasification unit (FSRU) "Golar Freeze," which is permanently moored at the Jebel Ali port in Dubai.

Det Norske Veritas (DNV) certified the test run, issuing a survey report upon completion. The Laby-GI compressor is used as a boil-off gas/minimum send-out compressor, according to Burckhardt. The compressor's design combines two sealing technologies in a single crank gear for lubricated or nonlubricated compression, allowing the Laby-GI to manage the compression of LNG boil-off gas at suction temperatures down to -250°F (-170°C) without preheating the gas or cooling the compressor, Burckhardt said.

The Laby-GI order was placed in April 2008, and was completed and installed in December 2009. Burckhardt installed the compressor skid within 10 days at the dry dock Keppel Shipyard in Singapore.

Capstone Turbine Receives Order for Six More Turbines

Less than a month after obtaining a 3 MW order from a large independent

continued on page 55