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Automation Key In Coalbed Methane

By J.P. Morgan

DENVER–Pennaco Energy Inc. has big plans for coalbed methane in Wyoming. The goal this year is to increase the company's proven reserves to more than 115 billion cubic feet by drilling more than 700 new producing wells. To achieve this increase in proven reserves, Pennaco must bring on two to three new wells a day.

The task of keeping up with this level of production was unrealistic using existing personnel and conventional methods. The management at Pennaco/Marathon (Pennaco is now a subsidiary of Marathon Oil Co., following a $500 million acquisition that was completed last spring) determined to use automation to keep up with the fast production pace and make the company the lowest-cost producer in the Powder River Basin.

Kevin Kilstrom, Pennaco/Marathon production manager, states the goals of automation. "This type of increase in production activities might normally mean doubling the number of pumpers/operators. Automation will allow us to keep up without adding pumpers/operators," he says. "Second, the gas and water flow data need to be collected remotely and integrated into our main production and accounting software. Third, our own staff needs to be able to add new wells into the automation software.

"Fourth, pumpers/operators need to be able to log on from their homes to help plan their days," Kilstrom continues. "Once logged on, they need alarms and real-time data to work with. They need to be able to look over an area map of the wells they work and then drill down (through available data) to the specific display of each well as required (Figures 1A and 1B). Finally, managers and other staff in the Denver office need to be able to log on from their desks through the company network to analyze data or troubleshoot."

Foresight

Some years ago, there were those who had the foresight to know that there was a gas shortage on the horizon. The coalbeds near Gillette, Wy., were only one of those areas that looked promising for development of natural gas reserves. A number of independent companies evaluated the Powder River Basin and decided to move rapidly toward lease acquisition.

The news traveled fast and bidding on oil and gas leases was intense. This required independents to get organized quickly. The competition for leasehold acreage in the Powder River Basin was growing, and there was a lot of work to be done in the interim. Each of the coalbeds had to be evaluated for drilling,

FIGURE 1A

Sample Area Map Display

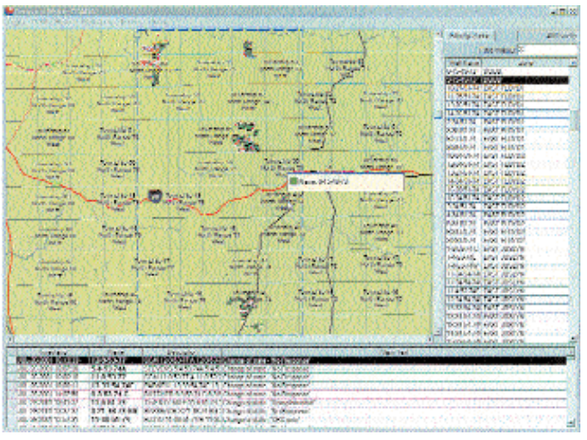
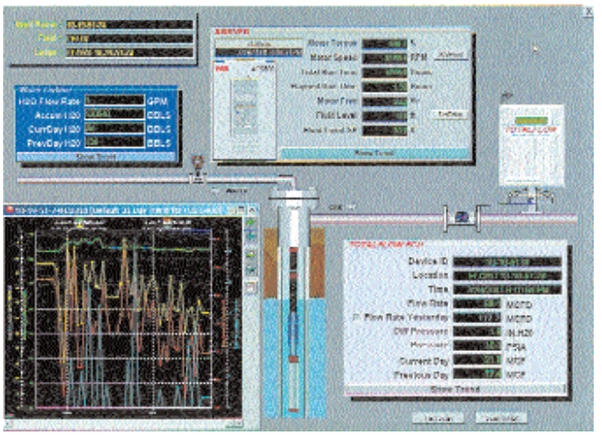


FIGURE 1B

Sample Individual Well Data Display



Once well operators log on, the SCADA software allows them to review "big picture" maps (left) of wells located within the areas of their responsibility and then drill down to view detailed data on any specific well (right).

Specially designed walk-in meter houses, such as the one shown here on Pennaco Energy's Kuhn Ranch Lease in Sheridan County, Wy., provide for permanent installation of flow computers, pump controllers and other instrumentation and electronics hardware.

well completion and production activity costs, all at a blazing pace. This type of coalbed methane production had never been done on a scale so large, and these independent producers were truly breaking new ground.

Pennaco Energy is one of the most aggressive operators in the Powder River Basin. In 1998, Pennaco assembled a team of people with the background and experience to build a startup company in a new, but unproven venture in the Powder River Basin. Exploration and development had to be done simultaneously with raising capital. The permitting of wellhead locations, roads, water outfall locations and gathering lines all had to be done prior to Pennaco realizing any return on its investment. Terry Dobkins, vice president of operations, is the driving force behind the Pennaco division of Marathon Oil. The group is flexible and fast moving, as evidenced by the more than 700 wells scheduled for drilling in 2001.

Coalbed Methane Attributes

Coalbed methane reserves are somewhat of a unique challenge to develop. The attributes of coalbed methane in the Powder River Basin are mostly positive. For instance, the gas is very clean, minimizing the amount of processing prior to going into a pipeline-quality transmission system. It contains minimal amounts of sulfur (sweet gas is much safer and easier to work with) and virtually no contaminants (mostly methane with approximately 2 percent N_2 and 2 percent CO_2). The low reservoir pressures–in the l00 psi or less range–allow for the use of less expensive polymer pipelines, and the shallowness of the wells means that highly mobile truck-mounted drilling rigs can be utilized to complete the drilling of new wells in only two or three days, on average. In addition, the co-produced freshwater can be used for irrigation, livestock watering or even drinking water.

Of course with the benefits of having low-pressure coalbed methane, there are some operational challenges, including:

- The lower-rank coals in the Powder River Basin produce less gas per ton of coal, therefore requiring more wells per Mcf of production;
- The low pressures mean compression costs are higher to move the natural gas product into a transmission system; and
- The high moisture content creates larger water pumping costs to de-water the saturated coals, as well as additional expenses in permitting for water disposal.

De-Watering

The job of getting gas out of the formation requires that water first be pumped off the well. The well may be as shallow as a couple of hundred feet or as deep as 1,500 feet. The depth of the gas well is based on the depth of the coal seams in that particular area. Of course, coal seam depth is relatively constant in the formation. Some coal seams in the Gillette area are at the surface. Wells in the surface coal seam are sometimes only 300 feet deep and are excellent producers.

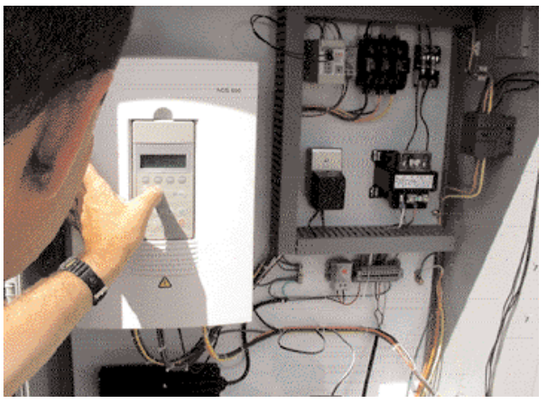
Each well needs to be de-watered in order to expose the casing to the coal seam. As the well is de-watered, it produces increased quantities of methane gas. Some producers will pump all of the water out of the tubing, while some producers will leave a specified level of water in the well. The techniques vary from producer to producer, but they all involve cycling of the pump or actual speed control of the motor driving the pump. Submersible pumps are the most common method of de-watering in the Powder River Basin. The submersible pumps vary from 1-horsepower, single-phase units to the most commonly used 10- and 15 horsepower pumps, on up to 20- or 25-horsepower units.

Submersible pumps are quite effective in this application where the water is clean, but there are some problems associated with submersible pumps in that, over time, small coal particles (or fines) can cause pump damage. A collapsed well also presents potential damage issues. In some cases, submersible pumps are being replaced with progressive cavity pumps (PCPs), which can also be cycled or modulated by controlling motor speed. While more durable, PCPs can be cost prohibitive. Certainly, a PCP is harder to justify in smaller, more marginal wells.

Water level in the well is frequently measured with a downhole pressure transmitter, mounted near the pump at the base of the tubing. Once the downhole pressure and casing pressure are known, the actual water level in the well can be calculated. The calculated water level can then be used for control purposes by the local remote terminal unit (RTU).

In some cases, the level control is done simply by switching the pump on and off, but in most cases, a variable frequency drive (VFD) is used. The local, on-site instrumentation needs to be capable of implementing an actual level algorithm that provides set point control as predetermined by the operator or production engineer.

Pennaco maintains a team of production engineers in its Denver headquarters that oversees gas production. The data from each well are made available to the staff in Denver using a Gillette-based server and a wide-area network. This is a



The automation system allows operators to monitor well sites and make changes remotely, enabling each operator to manage two or even three times more wells than before the system was put into place and helping Pennaco bring online more and more coalbed methane wells–700 are scheduled to be drilled this year alone–by more efficiently utilizing its existing operator staff.

critical component in helping Pennaco engineers achieve the company's production goals.

Water production information is also important for reporting purposes to the Wyoming Department of Environmental Quality. By authorized permit, the water is surface drained. According to regulations, this water must be metered, which is generally accomplished using turbine meters. This type of meter has a frequency output that is proportional to flow rate. The frequency output is terminated at the local RTU and totalized, and the data are stored by the RTU for a period of 35 days.

Gas Measurement

The natural gas measurement was originally done with a traditional mechanical round chart recorder. Pennaco, determined to leapfrog tradition, developed a totally electronic metering system. The primary element in the gas metering system is a V-cone, which allows for a shorter, straight run of pipe at the measurement point. This is important in the coalbed methane application because the wellhead is very compact. Producers are bringing the casing to the surface under a small (approximately four square-foot) frost box. With only four feet of horizontal pipe run, the piping then goes immediately back down into the ground. This makes for a very compact gas and water metering application. The flowing gas helps keep the temperature in the box above freezing, which then helps to keep the water lines from freezing when the well is not pumping water.

With the gas lines only coming out of the ground for a few feet, the temperature of the methane gas is kept constant. If the gas were to cool too much, the amount of water condensing from this moisture-saturated gas would create problems in the gathering line. The newer installations for Pennaco are using a specially designed walk-in meter house instead of the frost box-type enclosure. The meter house has a removable end that allows the well to be reworked at a later date, if necessary. The meter house also gives the technician a place to get out of the weather and provides for permanent installation of the instrumentation and electronics.

Pennaco is using ABB/Totalflow as the supplier of its measurement and automation system. The system includes RTUs, flow computers, pump controllers, supervisory control and data acquisition (SCADA) host software, and communications solutions.

The decision was made by Pennaco's Production Manager Kevin Kilstrom to move measurement to the wellhead, where it had previously been done at centralized meter buildings, often referred to as "pods." The wellhead application requires the instrumentation to be placed under the frost box or in the walk-in meter house. The chosen RTU is able to read outputs from the level transmitter, water meter, absolute pressure of wellhead casing, gas temperature, differential from the flow element, record the hourly data for 35 days, and execute control algorithms. The RTU also has a serial link to the VFD for MODBUS™ communication between the two, and storage of data from that device.

Automation

The inherent need to operate these wells as efficiently as possible led to the need to automate the well sites. Since average production is less than conventional wells, these coalbed methane wells demand less overall production costs to be viable. The control of the pump, measurement of water and gas, and the communication ability of the RTU meant that the sites were prime for remote telemetry and control. In fact, this was the ultimate goal for Pennaco.

Starting from scratch on the fields in Wyoming allowed Pennaco to make long-term plans that included remote operation and data collection. Each of the RTU units is fitted with a radio and fed through a repeater system to a host in Gillette. The host polls the RTU units on hourly intervals to keep the field operators and staff in Denver informed of operation and production variables. The automation allows Pennaco to capitalize on limited personnel in the field, and enables data to flow seamlessly through to the larger accounting and reporting mainframe in Denver.

Pennaco worked with the RTU manufacturer to develop a coalbed methane host software system that would support operations. The long-term project has developed into more of a partnership between Pennaco and ABB/Totalflow. This partnership would produce a modified version of the ABB/Ivision SCADA software that is especially adapted to CBM production. Pennaco had specific ideas on the approach for the software. Each of the well operators was to remotely access, monitor, collect, and even make operational changes in their own wellhead locations. The operator is ultimately responsible for the pumping and production of his own sites, and the SCADA system provides for this mode of operation.

The operator logs in over a phone line, Internet connection or (soon) truck-mounted radio using a laptop personal computer. Once logged in, each operator can monitor sites in his area and is able to make knowledgeable decisions on where problems and opportunities are. The operator can make changes remotely through the SCADA system that may increase gas production or simply monitor the site for problems. Operators are able to schedule site visits to more efficiently maintain each well site.

The ultimate goal is to efficiently utilize available operators as Pennaco brings more wells on line. With the

increased use of these techniques, operators that were once responsible for 50 wells before the automation system was put into place can now manage double and even triple that number of wells.

While Pennaco cannot say it went off without a hitch, the automation system and SCADA software have exceeded expectations. When there was a snag, the company was able to work through it quickly, maintaining focus on achieving the corporate production goals. ❐

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