Mobil Controls Costs at Major Oil Field Using Wonderware InTouch MMI, SCADA, and SPC Functionality

BAKERSFIELD, CA — On the flat, dusty plain west of Bakersfield, you can see the oil wells of the Mobil Exploration & Producing South Belridge lease for miles before you reach them. Day and night, 365 days a year, hundreds of these workhorses pump up and down, steadily harvesting the vast oil reserves under this region of the San Joaquin Valley. The South Belridge lease is one of Mobil’s flagship oil fields, yielding some 50,000 barrels of largely heavy oil a day from 750 producing wells. Mobil Oil is the second largest U.S. oil company, with worldwide revenues of $59.6 billion. Eighty percent of Mobil’s domestic oil comes from California, and sixty percent of that California oil comes from South Belridge.

Declining oil prices and a glutted world market have increased the pressure on Mobil to control costs while extracting as much oil as possible from their leases. Only six years ago, South Belridge was producing 35,000 barrels of oil a day. Mobil has since pushed that yield to 50,000 barrels a day while extending the life of the lease into the twenty-first century with the help of an enhanced oil recovery (EOR) process that injects steam into the ground to “sweep” the oil towards the wells.

The South Belridge lease now produces around a half million dollars worth of oil a day, but not without cost. EOR is an expensive process, because it requires a lot of above-ground facilities that exist just to make the oil recovery possible. “The entire surface operation consists of separating the oil and water we get out of the wells, cleaning up the water, and sending it back to the steam generators to be recycled into the steam injection system,” explained Bill Bissell, LAN Administrator. “The oil is what makes us the money; all the other facilities are what’s required to do business. So obviously, we need to control those non-revenue-producing costs as much as possible.”

The South Belridge team gained control over their costs by linking the existing network of Modicon PLCs to 22 off-the-shelf 486 PCs running Wonderware, InTouch™ human-machine interface (HMI) software in a Windows environment. Wonderware InTouch is an object-oriented, graphical HMI program used for creating SCADA applications for process automation. The new application provides significantly improved data acquisition, automated alarming and trending, and statistical process control (SPC), allowing engineers to pinpoint cost...
targets for operations and optimize processes to hit those targets. BCCK Western Controls system integrators from Bakersfield worked with Mobil engineers to develop the highly customizable application, which provides a uniform “look and feel” across the operation and allows South Belridge to share data not only throughout the lease, but with other sites linked to the Mobil WAN as well.

Enhanced Oil Recovery

Mobil has been operating its South Belridge oil fields for most of this century, so the oil that remains is difficult to recover. In Mobil’s enhanced oil recovery process, the heat of the steam injected into the ground makes the heavy oil more viscous so that it flows more easily, while the steam pressure pushes the spread-out oil toward the oil wells surrounding each steam injector, concentrating its volume so that it’s easier to pump. The South Belridge lease operates approximately 250 steam injectors for its 750 wells.

One of the ways the South Belridge lease achieves peak efficiency is by reusing or recycling not only the water involved in the EOR process but also much of the operation’s waste products as possible. “Along with the oil and gas mixture, we recover ‘sour’ gas from the well head,” explained Bissell. “It’s called ‘sour’ gas because of its sulfur content. We recycle this gas by burning it in our generators to make steam, but because of environmental restraints we have to clean it up first. We have two sulfurox plants that collect this waste gas and ‘scrub’ it to remove the sulfur. This process lowers our emissions levels.

On average, about 80% of what each well recovers is water, while 20% is oil. This emulsion is pumped to the oil and water treating plant, where the two liquids are separated. The oil/water mix first goes to free water knockout vessels where it separates and as much of the hydrocarbons as possible are removed. The crude oil is routed to the LACT or liquid accounting custody transfer facility where it’s stored before being piped directly to the refinery south of Los Angeles through Mobil’s M 70 pipeline. “The LACT meters are our cash register,” observed Bissell. “This is where we sell the oil to Mobil Pipe Line Company, which then takes possession of the oil and ships it to Torrance.”
Cost Controls

Fuel is one of the largest costs at Belridge, because the amount of waste gas they are able to recover is not enough to run the entire steam generation system. Their 50 steam generators burn about 50 million cubic feet of gas to produce 155,000 barrels of steam a day. The natural gas they use is piped directly from a Mobil field in Wyoming, but the fuel still runs $45 million a year. Even a 1% savings in fuel efficiency can save $20,000 a day.

The HMI lets operators see actual fuel usage at a glance and create setpoints and alarms to keep that usage within established parameters. “The system lets us do comparisons between generators and across time, look at fuel rates, steam qualities, production, turbine fuel, active and reactive power components,” explained E.D. Neilands, senior staff electrical engineer. “We can see which steam generators are producing the right quality and pressure, for example, so if we don’t need all the generators operating, we can identify which one is the best one to shut down.”

Mobil has three cogen units that generate electricity as well as steam. The three cogen units generate 3.2 megawatts per turbine for a total of 9.6 megawatts of power, but the operation still has to buy 5-6 megawatts from the local utility. “The HMI lets us see the whole distribution of power throughout the field,” explained Neilands. “Control over the cogen facilities is especially important for environmental regulations. We do continuous emission monitoring (CEM) of each turbine in the cogen facilities, and we want to use Wonderware to take the information from the PLCs every five minutes and populate a SQL Server database, which will generate automatic calculations and emissions reports that will be accessible by our environmental technicians and engineers at their desktops.

“We also included a nice little feature in our black start facility. This is a facility that generates enough power to restart the cogen in case of a complete power outage, so it’s a kind of insurance policy and rarely if ever used. We included step-by-step operating instructions online, so if the whole lease goes down, operators won’t spend time looking for the instruction book while we’re losing half a million dollars a day.”

The engineers have found that an added benefit of their new access to data is a significantly streamlined permitting process for changing or adding facilities. “Our EPA permitting process is a lot shorter now because they have confidence in the data we report to them,” observed Steve Glazner, electrical technician. “It used to take about three weeks to get a permit; the last one we got only took 48 hours.” Glazner believes this is the result of the combination of new emissions control procedures implemented through the PLC and Wonderware, the written protocol procedures, and the steam generators’ “fail-safe” setup. “As a fail-safe, each steam generator’s PLC monitors the pounds of sulfur being burned in the generator,” Glazner explained. “If the level nears the EPA limit, the PLC automatically shuts down the valve so that the limit cannot be exceeded.”

Statistical Process Control

Concern for the bottom line is integrated into the very organization of the South Belridge lease operation, which is divided into four “process teams,” each of which functions like a small operation unto itself. “We looked at our operations and determined that we have four main processes: oil production, water treatment, steam generation, and lite oil production,” explained Neilands. “Each team consists of all the people who work on that particular process. We set up supplier/customer relationships between each of the process teams and operate the facilities in that manner. The oil production team is responsible for the steam injection, the reservoir, and the pumping units; it ‘sells’ the oil to the oil and water treatment team, which separates the oil from the water, treats the water, and ‘sells’ it to the steam team; and the steam team not only generates steam but also produces and distributes power to its ‘customer,’ the oil production team, closing the cycle. The lite oil team handles the whole gamut for the 3,000 barrels of lite oil we produce a day.

“We’re a low cost producer, and this organization helps us control our costs. We set a target dollar amount for the cost of our oil production, and in order to achieve that we need to generate steam for a
certain dollar amount, operate the sulfurox facility for a certain dollar amount, and so forth. Each process team is responsible for operating its facilities so that it hits its target, and we know that if we all hit our individual targets, we'll be the lowest cost oil producer.”

One way Wonderware helps keep costs down is by improving troubleshooting of field equipment. “InTouch makes it easier to identify and remedy control and loop problems,” observed Glenn Chamberlain, electrical technician. “The data that we're now able to gather proves very valuable to the teams in their decision-making processes.”

To accomplish their targeted production, the Belridge teams need statistical process control (SPC) over the variables that determine production costs. “In order to produce to target, each team needs to track certain data we call key performance indicators or KPIs— things like cost of chemicals and steam-to-gas ratios,” explained Neilands. “We need to have precise control of all our variables to be able to hit our targets. We had been collecting SPC information manually, walking around with a clipboard putting dots on the chart with a pen, but we're automating with Wonderware's SPC module. The SPC module lets us display data in X-chart, Pareto chart, or histogram form, and allows us to see at a glance which facilities are producing at the targeted rate. We particularly like the ability to flag a data point and add comments to it, and the ability to assign causes to samples that fall outside control limits.

“Another nice feature that helps us reduce downtime and keep tabs on our operations is our Win911 system. We only have four operators on shift at night, so an operator responsible for a particular facility might be out checking field equipment and not realize he has a critical situation at his plant. If a critical alarm point is exceeded, like an emission limit at the cogen, or a high level alarm on a tank, the operator is paged and the pager digitally displays exactly what the alarm is, so he knows to immediately go and take care of business.”

A Hierarchy of Networks

A key part of the South Belridge upgrade was the implementation of a hierarchy of three networks to manage the high level of communications traffic. The actual processes in the field are controlled by 319 Modicon PLCs, most of which are connected on a Modbus+ fiber optic peer-to-peer network that operates at 1 mbps. The 50 or so PLCs still using Modbus are in line to be upgraded to Modbus+. The PLCs talk to 22 Wonderware InTouch nodes running on PCs in an Ethernet LAN that operates at 10 mbps. All the PCs have both a Modbus+ and an Ethernet card so they are connected to both the PLC and the WFW networks.

Most of the Wonderware InTouch nodes are located in the facilities out in the field, but five Windows NT terminals are located in the office. These nodes operate as data concentrators for each of the four process teams: oil and water treatment, oil production (steam injection), lite oil production, and steam and power generation. The fifth monitors total flow. Operators can view all data as well as control operations from the computer room in the office. Mobil's application is designed to provide a uniform “look and feel” across the entire operation, from the data concentrators down to the nodes in the field. From an overview screen, operators can zoom in and out on operations, facilities, or equipment by simply clicking on the object on screen if they want a closer look. A new screen with a detailed view of that object will appear. Clicking on a particular well, for example, brings up a screen depicting that well. The operator can then click on a portion of that object—say, a valve area—to zoom in on that detail. A button on the bottom of the screen lets operators quickly jump back to the overview screen, so they never get lost. Clicking on buttons or objects brings up dialog boxes or screens that let operators input values, view alarms, or manipulate control objects such as sliders. “It's very intuitive to learn,” said Bissell; “The operators just pick it right up.”
The data concentrators in the office provide a centralized view into the operations of the lease. “It’s a big place, so they save us a lot of time and legwork,” Neilands noted. “For example, one of our key performance indicators is steam pressure. Instead of going out to fifty steam generators and looking at the pressures and adjusting each one manually, now we can look at and adjust all the pressures from a single PC here in the office. If the process team wants to deny access to any controllable item, it can be password protected and will appear grayed-out on the screen.

“We need a lot of data here on the lease that doesn’t interest people back in Bakersfield or Dallas—things like process variables, control variables, setpoints,” he continued. “We gather information from thousands and thousands of points, but as you get farther and farther away from the lease users are interested in data from fewer and fewer of those points. Some of this information ends up in the Prism system on our mainframe in Dallas. For example, and all they’re interested in is the total volume of oil produced today. We have streamlined the data as it goes up the data pyramid. This 100 mbps network has an NT server that runs SQL Server. We put Wonderware data on the SQL Server so that it can be accessed with SQL queries.” The team plans to build a bridge between the 10 mbps network and the 100 mbps network, so that they can transfer data to the mainframe via TCP/IP through one of the NT workstations.

“We’re running the System Management Server (SMS) from Microsoft on the NT server to administer all the Wonderware terminals so that we can easily update software and not only access data from any Wonderware InTouch node, but actually take control of any node and operate it remotely,” Neilands added.
“This helps us instruct our operators, manage the system, which keeps getting bigger and bigger, and generally save us a lot of legwork around the lease.

“We’ve been in a state of rapid change throughout the lease, and the Wonderware applications have added to our success by allowing development of the MMI and SCADA systems along with the process team’s continuous improvement efforts,” added Chamberlain. “As the teams identify opportunities for improvement, application changes are made daily. With the equipment available a just few short years ago, these kinds of improvements would not have been possible.”

“The key is open systems,” Neilands concluded. “Wonderware lets us share data across applications, networks, and sites, so we can customize our application to fit our needs.”