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**DEMONSTRATION OF SUPERVISORY CONTROL AND
DATA ACQUISITION (SCADA) SYSTEM TO MANAGE
OILFIELD PUMP OFF CONTROLLERS AT THE ROCKY
MOUNTAIN OILFIELD TESTING CENTER
CASPER, WYOMING**

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Dan Newquist

**PREPARED FOR THE UNITED STATES
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Supervisory Control and Data Acquisition (SCADA) System

Abstract

PC-based SCADA systems are today widely accepted by the oil and gas industry, thanks to the increased power and capabilities of PCs, their reduced costs, and the wider use of PCs by energy companies in office and field operations. More and more field operators are using laptops in their daily work duties. This has made the PC the choice for field SCADA systems, and for making SCADA data available throughout company operations.

As PCs have become more powerful, it has allowed SCADA software developers to add more capabilities to their systems. SCADA systems have become tools that now help field operators perform their jobs more efficiently, facilitate in optimizing producing wells, provide an active interface for monitoring and controlling plants and compressors, and provide real-time and historical well data to engineers to help them develop strategies for optimizing field operations.

Introduction

RMOTC and Insight Automation Inc. entered into a technology transfer project to install state-of-the-art SCADA technology for NPR-3 facilities and pump-off controllers (POCs), with the objective of demonstrating the benefits of the technology in low-production, onshore stripper fields with limited manpower.

Alternative Technology

For several years, NPR-3 used the DOS-based Delta-X Control C™ software with Delta-X System 60™ POCs. Motorola radios provided communications between the wells and the central computer at the main NPR-3 field office, allowing production staff to analyze a well from the comforts of the office. The disadvantages of the system were the DOS environment and the inability to expand automation at NPR-3 into new areas.

RMOTC purchased a new computer for the SCADA system, and Insight Automation installed Energy Management Systems/4™ (EMS/4), WinGraph™ and Wonderware InTouch. This provides a Windows NT™-based SCADA solution for automating the existing POCs while permitting expansion of automation into other NPR-3 facilities, such as tank batteries. This new capability allows the DOE to offer existing and new potential RMOTC partners the ability to monitor the results of their testing on wells and other facilities at the Teapot Dome field.

The EMS/4 SCADA system is a series of programs designed to work under WindowsNT and Windows2000™ to communicate with Delta-X pump-off controllers, collecting data from the POCs and making it obtainable by a graphical user interface. Additionally, it

allows for other field devices to be added, with support for all major POCs, electronic flow meters, and programmable logic controllers.

WinGraph is the GUI that works directly with the EMS/4 software to upload dynamometer cards from field POCs and provide the data to leading analysis programs, such as Theta and Nabla. Additionally WinGraph is a user interface that allows operators to monitor and adjust wells from the PC interface.

Field Data and Results

About 50 oil wells at NPR-3 have been equipped with the Delta-X System 60 POCs, using Motorola RNet™ radios. The radios are rated for a 2-watt power output, and operate in the 400 MHz frequency range. The transmitter uses directional yagi-type antennas. The POCs use a mechanical strain gauge, or transducer, mounted on the walking beam of the pumping unit to sense the load on the rod string. When the load indication shows that no more fluid is being pumped, the computer shuts down the pumping unit. This provides dynamometer cards to observe the performance of the downhole pump and rod string.

The SCADA system has the capability to work with many other types of oil field equipment. In fact, any operation that has sensors and can be remotely operated can be added to the system. The DOE is now looking at adding tank level controllers at some NPR-3 tank batteries to the SCADA system.

When the EMS/4/Wonderware SCADA system was first installed, several wells frequently produced the status message, "Pumping, stroke unknown." Although this had occurred with the older Control C system, it was not detected as frequently, primarily because of the increased polling setup of the SCADA system. The EMS/4 SCADA system allows wells to be polled much more frequently, providing quicker notification of problems at wells and more historical trending information. The more frequent polling made the problem much more apparent. The overview map of the field designed in the Wonderware InTouch GUI made it even more obvious.

As finally diagnosed, the problem was that when the radio was keyed, it interfered with the System60 POC, causing it to go into an unknown state. Delta-X was consulted, and an engineer suggested checking the radio's electrical grounding. An AC ground was found in the enclosures, but there was no earth ground to the radio case or POC backplate. The DOE project engineer hired a radio technician to check the antennas, install the grounds, and check the power output and frequency of the radios. Additionally, while checking POCs, several antennas were found to be pointing in the wrong direction, the result of years of abuse by the Wyoming wind.

After the SCADA software was initially installed, a problem surfaced where the EMS/4 DDEServer was inadvertently dying. To correct the problem and get the system running again, field personnel would reboot the PC, which properly restarted the SCADA programs. The frequency of this problem varied from one day to many, making it hard to

catch and cure. Insight Automation provided instructions for catching a “debug” file before rebooting the computer, which the DOE project engineer was able to do. The debug file was e-mailed to the vendor, which then worked with the EMS/4 software developer to create a software patch that appears to have solved the problem.

The POCs have their own maintenance requirements and expenses. Transducers, cables and motherboards have a way of failing occasionally. Production staff were trained to troubleshoot and maintain the POCs, but the smaller workforce makes it difficult to spend time on POC’s after working on down wells and production facilities. As a result, there are wells in the SCADA system that need transducers or other parts replaced, and the work doesn’t get done right away, reducing the effectiveness of the system.

Several POCs have a problem with floating cards. The production staff can program set points on the dynamometer cards to tell the POC when the well is pumped off and should be shut down, or when the rods may have parted. If the beam transducer or its cable have failed, the dynamometer card will “float,” making it appear that the load on the walking beam has changed radically since the set points were established. The set points then float up or down, sometimes completely off the screen. This either causes the well to shut down prematurely, or lets the well keep pumping long after it is pumped off, causing unnecessary mechanical wear and energy consumption.

Production staff members have different degrees of computer skills, and consequently, some have taken better to the new system than others. All had learned to use the old Control C system, and some were frustrated with having to learn a new system. As a result, they were printing out the reports, but did not know what to do with them. The old system had allowed them to look at one well at a time, while the new one showed all the wells at once.

The SCADA system is designed to immediately prioritize wells according to status (wells coded with red or yellow are automatically given precedence over wells coded with blue or green and operating normally). This reduces the daily time required to review all wells’ performance and determine where to direct maintenance efforts for the day from 90-120 minutes to less than 30. In fact, the production supervisor can usually review all 45 wells on the system and identify those wells that need work in only 10-15 minutes. Because this took up to two hours with the old system, there were times when a pumper doing his rounds might discover a well malfunction before it was noted on the computer. With the system set to “round-robin polling,” problems become obvious the instant the well symbol changes color on the field overview screen.

Production data are inconclusive in terms of the benefits of the SCADA system. During the trouble-shooting phase, some wells may have been shutting down prematurely, and the pumpers were operating some of the POC wells on “hand” while the radio and computer problems were being worked out. In addition, the radio interference problems with the POCs existed before the SCADA system was installed, so there has probably been some lost production all along, although the new system helped identify and correct the problem. Work continues to diagnose and repair the floating card problem.

With most of the initial problems corrected, the system is working well. The wells only pump as long as it takes to produce the fluid in the well bore, saving electrical power and reducing wear and tear on the equipment. This helps maximize production, while minimizing maintenance and energy costs. And because the SCADA system allows production supervisors to identify malfunctions within minutes, wells can be returned to production more quickly. The system also eliminates much of the time pumpers used to spend during their rounds checking wells that were working normally, allowing them to concentrate on correcting problems.

With the initial POC SCADA applications up and running, NPR-3 can now focus on how to use the system to expand into other facilities, such as tank sets, injection facilities, LACT facilities, and plants. Any new facility added to the system will continue to help the limited workforce perform more effectively, and improve the overall operation of the Teapot Dome field.

The advent of Internet SCADA software could be a future benefit for RMOTC. As companies utilize the Teapot Dome field for conceptual testing, it will be important for them to be able to continuously monitor test results. Because of the remoteness of the facility, cost becomes a factor for maintaining operators and engineers on site. The Internet can provide the interface for RMOTC to provide data through the EMS/4 SCADA system to engineers anywhere in the world. The DOE already has a high-speed connection to the field offices, so adding the Internet interface may be the next logical step.