Daily Monitoring Reduces Cost of Production in Marginal Wells

The economics of a marginal well is highly sensitive to the price of oil and cost of production. Without improvements to production efficiency, marginal wells often must be shut down or risk operating at a loss. Because rod-pumped wells correspond to this pattern, with many of the wells producing less than 10 BOPD, a 4-year system-development effort was undertaken by Petrolects, a California-based engineering consulting firm, and Bakersfield-based independent producer Vaquero Energy to improve production efficiency. The Marginal Expense Oil Well Wireless Surveillance (MEOWWS) oil-production monitoring system is the result of this development effort, primarily funded by the U.S. Dept. of Energy. The system allows marginal wells to be economically monitored daily, allowing operation with near-optimal efficiency.

Detection Methods

During the first 2 years of the study, small, self-contained, wireless vibration sensors were attached to different sections of rod pump units. Signals induced by vibration of the pumping unit during fluid pounding were transmitted to a base-station computer in the field office. The operator could then identify problem wells by reviewing transmitted data. Statistical analysis of the vibration data was performed, demonstrating that acceleration sensors were able to detect fluid pound when the well was pumped off. Problems encountered during testing of the vibration-detection system included high power usage, which led to short battery life, and the high cost of the sensors.

In the third and fourth years of the MEOWWS project, the method used to detect the pump-off condition was re-evaluated in an attempt to overcome the most serious problems encountered during the first phase. Three methods to determine the operating condition of the pumping unit in real time were tested and compared—vibration measurement, acoustic emissions from surface equipment, and flow measurements of produced fluids. Flow measurement was determined to hold the greatest promise for a reliable, economical, easily installed well-operation sensor and was chosen for further investigation.

System Development

A proprietary method of detecting outflow from a beam pump was conceived by the investigators. The method involves a simple and direct detection of flow through surface piping. A surveillance system was designed to suit the advantages of the flow-detection method: simplicity, reliability, direct monitoring of production, ease of installation, and low cost. The flow sensors are integrated into a well pump surveillance unit (WPSU). Each WPSU contains an inexpensive low-power microcontroller and a 900-MHz spread-spectrum radio modem. The microcontroller interprets readings from the flow sensor, using proprietary software to measure the well's state of health and the volumetric pumping efficiency. Readings are saved over a period of hours or days.

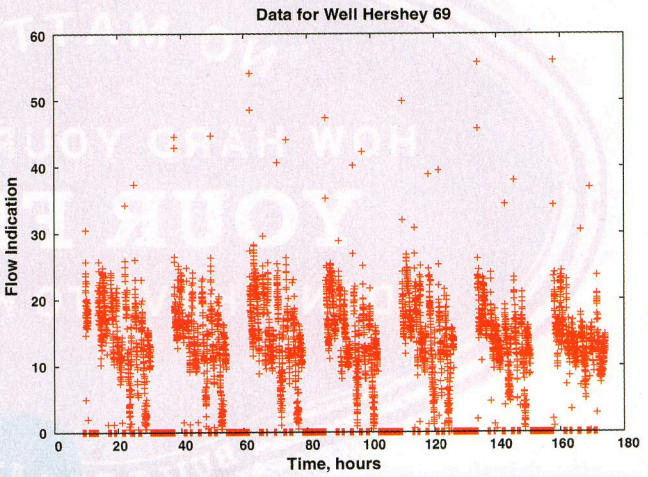

Fig. 1— MEOWWS flow data recorded over a one-week period.

The power requirements of the WPSU are low enough to permit practical battery-powered operation over a period of years without an external electrical supply, eliminating the need for installation of expensive alternating-current power lines or costly and vulnerable solar-power arrays.

The WPSU transmits data to a base station located in the field operations office as frequently as is required by the customer's needs. The system is designed to transmit information on a daily basis, minimizing its contribution to the problem of radio frequency congestion that is increasingly troubling users of supervisory-control and data-acquisition systems. At the base station, readings are compiled by software to a tabular or graphical format that is easily interpreted by operations personnel. Base-station data are made available through a local area network, or across the Internet, by an integrated Web server. Data are also archived for future reference.

Data Reveal Revitalization

Fig. 1 shows data taken by one WPSU over 1 week. The pump, the flow of which was measured, was operated by a timer, and the periods during which the system is running are clearly visible. Also visible is a decline in production as the oil in the formation is pumped down. The data are used to calculate estimated pump efficiency; the efficiency of the pump for which measurement is shown was approximately 20%. On the basis of data acquired and processed by the monitoring system, Vaquero Energy has been able to increase production and decrease energy usage at test wells.

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Information provided by Mason Medizade, President, and John Ridgely, R&D Engineer, both of Petrolects LLC.

experts are also engaged at the strategic level, particularly in shaping research and product development agendas. The evidence is strong that these employees highly value the positions they have gained.

Progress in the technical ladder also involves active participation in our Eureka communities and special interest groups; these are self-governing communities focused on specific domains, such as chemistry, geophysics, and well engineering—more than 150 in all.

These bodies each democratically elect leaders every year, enabling the groups to be independent of the management organization even as they are a part of the company fabric. Groups set their own agendas, may hold conferences and workshops, coordinate subgroups, maintain websites, and exchange information throughout their membership as well as with other Eureka bodies. In its synergy of knowledge management and technical career development, Eureka is highly motivating to its active members as well as being an innovative approach to optimizing new technologies and solutions.

Intensify Efforts To Interest Women in E&P Careers

On a worldwide basis, the industry needs to intensify efforts to interest women in technical E&P careers. There is no justification for concentrating on only 50% of human brainpower. Our company has been actively hiring women into its technical workforce for more than a decade, and about 25% of our current hires for positions in field engineering, geology, geophysics, and reservoir engineering are women.

If female participation in E&P technical professional employment is to grow, one of the most important requirements is that the industry be flexible in accommodating mobility and life-cycle needs. Linked to gender diversity is the increasingly important challenge of managing dual careers. Partners of today often have no desire to sacrifice or suspend their professional lives. Quality-of-life choices often depend on dual incomes, and relocation packages are rarely adequate to offset the loss of a salary. Yet ours is very much a global industry requiring the mobility of a portion of its technical and management workforce. We will have to be far more innovative and flexible in the ways we approach transfers, training, educational benefits, spousal employment concerns, and employee career management to meet the needs of dual-career couples.

A Global Industry Must Use Global Talent

While the industry's human capital deficit is perfectly real, the decline in petroleum engineering graduates is essentially a western phenomenon. Elsewhere, as the world's E&P horizons increasingly shift eastward, the numbers of graduates in this field show no decline and in many cases are increasing. Graduates from programs in China, Russia, India, and numerous other countries are a growing source of highly qualified engineers. Not only is the trend to hire these engineers simply logical as the activity moves eastward, but the recruitment and retention of these technical professionals will necessarily play a vital role in overcoming the human capital shortage.

The simple fact is that there will not be enough people in the industry with the previously expected years of experience, based on the traditional model, to meet the activity demand. Not every operation will be led by someone with 10-plus years of background. Our challenge is how to ensure the same competence, safety, and service quality in an operation headed by someone with only 3 years' experience. An important first step is to intensify the training the employee receives through the use of simulators, special high-exposure temporary assignments, the use of online multimedia materials and, perhaps most important, effective mentoring.

We also must use technology to make equipment and processes simpler, more intuitive, and less prone to human error. Probably the best example is in the drilling and measurements business. I remember my field days when the king of the rig floor was the directional driller who did everything based on the weight indicator, feeling the drillpipe...and his gray hairs! By putting the smarts into the tools, we now drill far more complex wells much faster and more reliably, and without most of the gray hairs, either. We have just commercialized a process-control technology that monitors coiled tubing as it is being run in and out of the well, alerting and even controlling the system if certain parameters are exceeded. Real-time capabilities play an important role today, allowing experts to be thousands of miles away and still monitor a fracturing treatment, for example, or participate in other key operational decisions.

Ready access to knowledge is another key element. The program discussed above is one part of that. Another is a system to capture, manage, and share knowledge. Ours includes an easily searchable repository of the corporate knowledge across all domains and also enables field engineers to contribute new ideas, best practices, and lessons learned. Complementing the database is a 24/7/365 help-desk hotline to access additional expertise for handling critical operational issues.

A Challenge, but Not Insurmountable

The industry faces a significant challenge in marshaling the expertise critical to meet growing market demands. We believe that the ideas discussed here will help place our company in good stead. We don't have all the answers; ideas from others will help. We are a resourceful industry and will meet the challenge. Of that I am sure. I am equally sure that this is a great and exciting time for young engineers to come into the industry. I wish them well, and I am envious! JPT

Technology Update

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A study performed by Vaquero concluded that implementation of the new system could result in improvements of up to 1,000 bbl/month of oil over the current 30,000 bbl/month of oil and an additional 735 Mcf/month of natural gas over the current 21,000 Mcf/month. Because worn pumps could be identified and repaired promptly, an overall pump efficiency could be achieved and electricity costs reduced.

Other estimated cost savings in a field of 200 wells are $4,000 per month in personnel time and $2,000 per month in electricity cost. It is also expected that the system could enable some inactive wells to begin producing again. Plans include further field testing prior to large-scale deployment and the development of an economical automated Pump-Off Controller that uses flow indications from the system sensor for automatic control of the beam pump at the well location. Such a controller could enable the use of automated control on marginal wells that have previously not been deemed candidates for more expensive control techniques.

Petrolects plans to expand the usage of the surveillance sensor to monitoring of gas wells, gas-oil-water pipelines, fluid leakage, and wax formation in pipeline networks, gravel/solid injection systems. JPT