

Innovations in Real-time BHP/BHT Well Monitoring Systems

The increased need for real-time bottomhole pressure and temperature data to help reduce lifting costs in the recovery of both conventional and heavy oil, has led to the development of several innovative well monitoring technologies. PROMORE Engineering Inc., an Alberta-based company was formed in 1994 with the mission to “provide innovative solutions to production optimization and monitoring of reservoir environments.” Through the utilization of an electronics free downhole sensor, the company has developed several monitoring systems particularly suited for heavy oil and thermal recovery processes including: casing, conventional tubing and coil tubing systems, high temperature critical application sensors, cost-effective pump control and production optimization systems.

The company’s original “claim to fame” was the design and implementation of a permanent sensor system that was cemented in place on the outside of the casing. Both formation pressure and annulus pressure can be monitored over the complete life of the well (applications have been in place for more than four years and are still operating reliably). A casing conveyed system is well suited where the client does not want any impact on the production environment or where annular sizes prevent running a tubing conveyed configuration. The tool can be used to understand cementing practices and then monitor the pressures during the drilling of the horizontal section of the well, particularly when drilling underbalanced. Casing conveyed systems then remain in place for the life long optimization, well testing or pump control applications.

It was through these casing conveyed installations that PROMORE was asked by several clients to develop a higher temperature casing conveyed system for use with their single well SAGD process. The company worked quickly on the development of a 200° C system for this project. This in turn led to the development and release of a 250° C system. The company is currently developing a 300° C system for release in 1999. These high temperature and high pressure sensors are also well suited in deep critical wells where natural reservoir temperatures exceed 175° C.

The development of high temperature well monitoring systems opened the doors for the monitoring of SAGD, SWSAGD and other thermal applications. Real-time production data gives the operators a better understanding of the effectiveness of SAGD and

other thermal recovery processes. Steam generation at surface and the injection and placement of steam in the reservoir can be monitored closely and continually adapted to operational parameters. Real-time monitoring and control provide for a more cost-efficient production process by helping to understand continually changing development of the steam chamber and thermal process (Figure 1). PROMORE has been involved in most SAGD and thermal projects in Alberta. They have developed a strong track record in the design and installation of real-time bottomhole pressure, temperature and flow monitoring systems for clients in the United States and Venezuela.

The real key to the company’s success has been the continual effort to “push the envelope” with regards to conventional thinking on how to install downhole instrumentation and in the design and technical limitations of downhole sensors. This combined with the fact that the sensors operate without the need for downhole electronics or batteries, creates an extremely long-term reliable system.

The company’s technology has evolved, due to the demands of the industry for high temperature data and the increasing use of endless or coiled tubing in thermal EOR projects. In conjunction with Alberta Energy Company, the company has developed a dedicated monitoring system which is coil tubing conveyed; ideally suited for horizontal wells. This allows for the placement of multiple pressure and temperature measurement points anywhere along the wellbore. The CT-MORE system is ideal for complete horizontal profiles in both cold production and thermal recovery processes. The company has also designed and installed fibre optic deployment systems for complete temperature profiles in lower temperature applications and has utilized other technology where extremely high temperatures exceeding 350° C have been reached.

Another innovative well monitoring tool that the company has developed is the MORE^{HOC} (heavy-oil control) real-time pump control system. The technology is an adaptation of their tubing and casing conveyed monitoring system, and is specifically engineered to provide an economical solution to maximize productivity and reduce lifting costs. The HOC tool is designed to provide control based on the most important parameter, bottomhole pressure, (Pwf), not unreliable surface parameters. Using the true Pwf

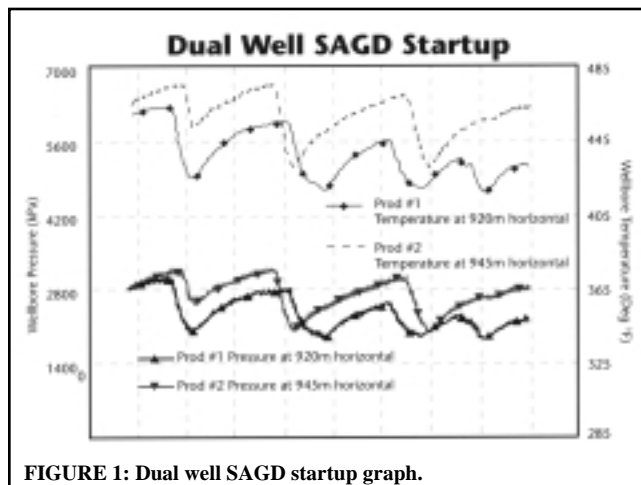


FIGURE 1: Dual well SAGD startup graph.

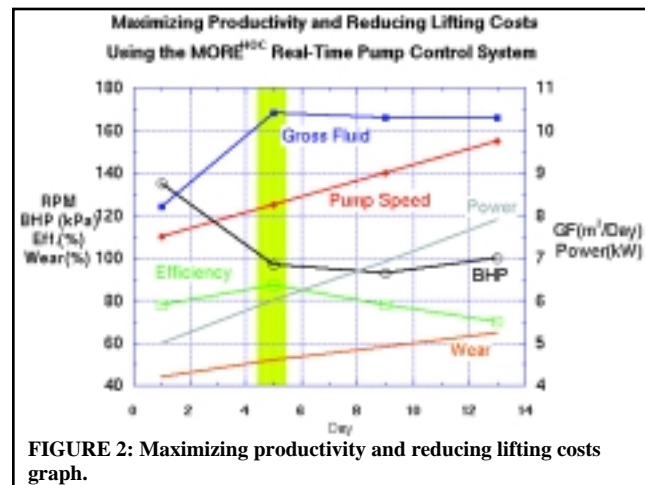


FIGURE 2: Maximizing productivity and reducing lifting costs graph.

in conjunction with variable frequency drives gives operators' reliable data that will allow them to operate wells at maximum drawdown without the fear of pumped off conditions and subsequent pump failures. In addition to the increased production and reduced operating costs the MORE^{HOC} System provides reservoir information used to optimize infill drilling programs and understand longer term reservoir practices (Figure 2). Real-time pump control helps operators understand reservoir performance and to properly design pump and lifting equipment. Combine these benefits with the low initial cost of the MORE^{HOC}, reduced workover frequencies, pump replacements and energy consumption and you have an extremely economical pump control system.

Real-time monitoring technology will continue to play an increasing role in reducing the overall costs associated with both conventional and EOR processes. Real-time monitoring gives operators the ability to be more pro-active in optimizing production practices to reduce overall cost. One of the keys perhaps to continuing the development of heavy oil fields regardless of market conditions, is the use of real-time permanent bottomhole pressure and temperature monitoring systems. 4