Applications of new managed pressure system in Brazil, S. Texas prove capability, repeatability

Editors Note: This is a follow-up to the article titled "New drilling method is based on closed-loop system, micro-flux control," published in the July/August 2006 issue of DRILLING CONTRACTOR.

By Helio Santos, Impact Solutions Group

The Secure Drilling system was first used to drill wells for Petrobras in 2006 to prove its capability to be used with cuttings at high rates of penetration and to demonstrate its reliability and repeatability. Field applications were successful.

SECURE DRILLING IS a new managed pressure drilling technology designed to improve drilling in most conditions, from simple wells to high-pressure, narrow-margin, offshore and other challenging wells and to significantly increase safety through automated kick detection and control. The system uses a closed-loop drilling process that allows for real-time identification of micro-influxes and losses and the control and management of downhole pressures through an automated data acquisition and computerized pressure-control system. It was successfully tested with water- and oil-based mud at the Louisiana State University Well Control Facility in 2005 and early 2006, with the first wells drilled in the summer and fall of 2006 with **Petrobras** and **Chevron**.

FIELD APPLICATIONS

The objectives of the first wells with Petrobras and Chevron were to confirm in field applications the accuracy of measurements observed from the system during the LSU tests, to prove the its capability to be used with cuttings at high rates of penetration, and to demonstrate the reliability and repeatability of the overall system. In each objective, the system performed successfully in the field.

FIRST WELL — PETROBRAS

In early 2006, Petrobras contracted with Secure Drilling to perform a 4-well evaluation program, starting with a simple land well and progressing to more complex scenarios. A shallow exploratory well was selected. A Petrobras kelly-equipped rig without automation was chosen with the objective of confirming the ability of the Secure Drilling system to be used on virtually any rig. The first well was drilled in August 2006 in northeastern Brazil using a water-based drilling fluid.

The first well contemplated the use of Secure Drilling for the 8 ½-in. phase.

The installation of the system was conducted while the rig was drilling the first phase, with the hard pipe needed for the operation prepared and welded at location. When the BOP was installed, the rotating control device was mounted, all the connections made, and the 8 ½-in. phase was ready to be drilled using the system.

A total of 1,824 ft (556 m) of the 8 ½-in. section was drilled in 6 days without problems presented by the system. During this period, 3 cores were taken, and the flow was kept through the Secure Drilling manifold. Flow-in was taken from stroke counters. In addition to the Secure Drilling manifold with its flow meter and backpressure sensors, a standpipe pressure sensor was used. Information gathered during the drilling of this well included the impact of pipe movement on flow and flow measurements, the confirmation of the benefits of using a top drive versus a kelly on the wear life of the element in the rotating control device, the interplay between the system and the rig's drilling controls, and the types of drilling data from the system and form of display of that data that the drillers considered important and helpful.

With the information gained from this first well, several improvements were made to the system. The first was to add a remote Secure Drilling panel in addition to the control panel located in the dog house. The purpose was to allow operations to be monitored from outside the rig floor. This additional panel was found useful for the company man, tool pusher and Petrobras' personnel responsible for the operation. Another improvement was to locate a remote Secure Drilling panel in front of the driller so he could see the measurements being acquired with the system and compare that data with other data gathered by the rig (implemented in the second well for Petrobras). In addition, the project identified improvements in screen layout, the processes for screening potential kicks and loss data when the rig is not drilling, addressing anomalies created by pipe movement and in the interface with the driller.

The results of this first well confirmed the system's ability to operate in the field, to identify changes in flow on a real-time basis and to be installed on most rigs with minimum modifications.

SECOND WELL — CHEVRON

In September 2006, Secure Drilling was used on a deep well in South Texas for Chevron. This well was drilled using an oil-based drilling fluid, and the rig was a larger, more automated rig equipped with a top drive. The second well, following the planned increase in complexity and difficulties, was more challenging than the first in many respects. First, the ROP for the well was at times close to 300 ft/hr, and in the 12 ¼-in. phase, the flow rates exceeded 700 GPM. The mud weight also reached more than 17 ppg by the end of the 8 ½-in. phase at 13,000 ft.

A driller interacts with the Secure Drilling system during the second well for Petrobras.

To have the possibility of conducting additional tests, including experiments with leak-off test and higher pressure procedures, rig connection to the Secure Drilling system had both low-pressure and high-pressure lines to allow testing to be made when the rig's BOP was closed. This way the drilling fluid return to the Secure Drilling manifold could be effected with different options.

The first test of the system on the Chevron well was conducted while drilling the 12 ¼-in. phase. The objective was to demonstrate the system's ability to handle high flow rates and a significant cuttings load. In this test, the system operated without problem at close to 800 GPM with an ROP of more than 250 ft/hr. The backpressure generated at surface during drilling was small, confirming that the test could proceed with the Secure Drilling system for the 8 ½-in. section, where it was planned to be used for the entire section.

Before drilling out the cement and shoe, flow tests were conducted to fingerprint what would be a normal condition for pumps when shut down and to identify the flow conditions with pipe movement (back-reaming and reaming back to bottom). Tests were conducted to confirm the system's ability to consistently hold a desired backpressure. This procedure is part of the standard steps to be done with the system before drilling out the shoe. A total of 2,775 ft (845 m) of the 8 ½-in. section were drilled in 7 days without problem. Repeatability and reliability were confirmed with this well.

The Chevron South Texas well demonstrated 2 important attributes of the system. First, the well confirmed the effect of pipe movement on the flow-out measurement in the system identified in the first Petrobras well. In particular, this result showed the ability of the system to identify minute changes in flow with pipe movement. In fact, the system was able to "see" on the screen the tool joints entering and leaving the well and passing through the rotating control head.

Second, the well confirmed the system's ability to detect small influxes during connections. At more than 12,000 ft and using an oil-based mud, the system was able to detect small deviations in flow, when the pumps were shut down to make a connection. The static mud weight would be increased slowly, and it was observed the "normal" connections and the "abnormal" ones very clear. After the increase in mud weight, the following connections would show no influxes until a higher pore pressure zone was crossed again.

The information gained during the Chevron Texas well demonstrated that the influxes observed in real time during drilling were directly correlated to the gas shows from the mud logging at the location, usually detected at least one hour later. Depending on the volume of the influx taken during the connection, it was possible to observe with the Secure Drilling system the gas influxes in real time and follow them to surface.

LESSONS LEARNED AND NEXT STEPS

The basic lessons learned from the first 2 wells using the Secure Drilling system was that the results seen at LSU were repeatable in the field and the system was capable of working with oil-based and water-based fluids, handling high volumes of fluids and cuttings and detecting and following influxes and losses on a real-time basis.

With the results of the Petrobras and Chevron wells in hand, various modifications and improvements have been made to the system to increase accuracy and user flexibility. Changes have been made to the screen display to add data and information desired by the drillers and to address readings on the system when not drilling. A dedicated monitor for the driller and multiple remote panels have been added to increase information flow at the rig.

The second well in the Petrobras program began in October 2006 using a larger rig equipped with top drive. Other wells using the Secure Drilling system are currently planned for Europe, the United States and the Middle East in late 2006 and early 2007. The combination of the Secure Drilling system with other emerging technologies is also being planned for testing in the near future.

For additional graphics detailing the field applications of the Secure Drilling system, please go online to www.drillingcontractor.org.