Industry learns to get most out of UBD, MPD

ACOUSTIC TELEMETRY

ACHIEVING REASONABLE telemetry data rates for measurement while drilling (MWD) and logging while drilling (LWD) during underbalanced drilling can be problematic with the two commonly used telemetry techniques, mud pulse telemetry and electromagnetic telemetry.

On the other hand, acoustic telemetry, based on the propagation of stress waves through the drill string, is particularly suited to operate in underbalanced conditions.

Halliburton successfully commercialized the first acoustic telemetry system in 2000 as part of a drill stem testing system. Environmentally challenging MWD/LWD underbalanced applications and a need for higher throughput required a complete redesign of that system. This paper will discuss the system design considerations, data rates associated with different modes of operation and the results of initial field tests.

Acoustic Telemetry Delivers More Real Time Downhole Data in Underbalanced Drilling Operations (IADC/SPE 98948) WR Gardner, L Gao, C Robbins, RE Hyden, EJ Linyaev, J Moore, Halliburton.

98077: At the Mars Tension Leg Platform in a deepwater Gulf of Mexico well, Shell successfully deployed an automated bottomhole pressure control system called Dynamic Annular Pressure Control (DAPC) to solve lost circulation and hole instability problems.

DAPC IN DEEPWATER

Shell E&P successfully deployed an automated bottomhole pressure control system developed by Shell International R&D called Dynamic Annular Pressure Control (DAPC) to solve lost circulation and hole instability problems in a deepwater Gulf of Mexico well on the Mars Tension Leg Platform, after two failed sidetrack attempts. DAPC is designed to apply controlled annular surface pressure with the goal of maintaining constant bottomhole pressure.

The DAPC system was fabricated, installed and tested on a fast-track basis after a review of the technology indicated a high likelihood of enabling the Mars A 14 well to be drilled without problems. It also has been demonstrated as a promising new tool to solve drilling problems associated with reservoir depletion.

First Deepwater Application of Dynamic Annular Pressure Control Succeeds (IADC/SPE 98077) VC Roes, D Reitsma, Shell; L Smith, Signa Engineering Corp; J McCaskill, Power Chokes; F Hefren, Mineral Management Service.

CUTTINGS TRANSPORT & FOAM

Knowledge of cuttings transport efficiency under downhole conditions is essential for safe and economical foam drilling. Previous cuttings transport studies with foam are limited to low pressure and ambient temperature conditions. This paper presents an experimental study of cuttings transport with foam in a horizontal annulus under simulated downhole conditions.

Experiments were conducted to determine the effects of polymer additives, foam quality, flow velocity, temperature and pressure on foam cuttings transport. The results show that a higher annular flow velocity is needed for cuttings transport with foam than with traditional water-based muds. This paper will help to better design foam drilling and cleanup operations.

Underbalanced Drilling: Experimental Study on Cuttings Transport With Foam Under Simulated Horizontal Downhole Conditions (IADC/SPE 99201) Z Chen, RM Ahmed, SZ Miska, NE Takach, M Yu, MB Pickell, University of Tulsa.

TESTING THE VALUE OF MPD

Is this the beginning of the end of weighted mud systems? An advanced well control practice called Managed Pressure Drilling (MPD) is staged to challenge the conventional drilling practice of when in doubt, "weight it up."

A drilling hazard mitigation multi-well trial was carried out to investigate and quantify the reduction in ROP as a result of mud weight increases to overcome troublesome formation overpressures and associated High Pressure Low Volume (HPLV) nuisance gas. Without increasing mud weight to control overpressures, MPD technology was applied to safely and cost effectively drill through overpressures and avoid an intermediate casing string normally used to isolate a loss zone.

MPD trial results examined in this paper addresses many of the issues regarding large-scale introduction of the system to other fields.

Managed Pressure Drilling (MPD) Field Trials Demonstrate Technology

Value (IADC/SPE 98787) J Saponja, AR Adeleye, Anadarko Canada Corp; B Hucik, Canadian Natural Resources Ltd.

MPD IN VENEZUELA

San Joaquin Field in Eastern Venezuela, with a daily production of more than 800 MM cu ft/day is the nation's most important gas field.

Vertical wells have been drilled through two shale sandstone layered formations where the gas payzones are located. The extent of the drilling problems is reflected in the 2003 average fluid losses, which was more than 4,000 bbl per well. Managed Pressure Drilling seems the logical next step.

The two most important formations are Merecure, with 1,500 ft of thickness and 25 layers (pressure ranges between 4,000 psi and 700 psi). San Juan Formation has its own considerations, with upper layers depleted and fractured, and a pressure differential of 2,000 psi.

The first challenge was to generate a geomechanic model, which used "breakout control" theories, for the development of the mud weight window to assure hole stability.

Well planning included "effective ROP increase" criterions, high durability drill bits, aggressive performance for favourable drilling conditions and parameters control. Five wells have been drilled without loss circulation reports, a 70 percent increase in ROP and a reduction in total drill bits used. These have been important results and a very good start for the learning curve in this technology implementation.

Managed Pressure Drilling (MPD): Planning a Solution for San Joaquin Field, Venezuela (IADC/SPE 99116) RA Soto, JJ Malave, M Medina, CE Diaz, Petroleos de Venezuela SA.

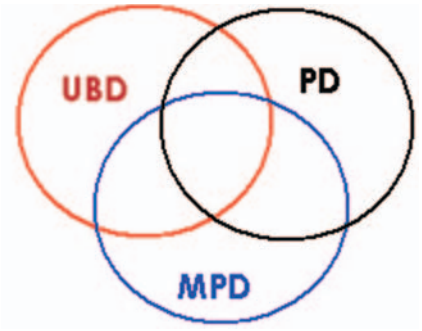
ADVANCED DYNAMIC MODELS

This paper focuses on how advanced dynamic models can be best used in critical drilling and completion operations. Two examples from recent managed pressure operations in North Sea wells are presented.

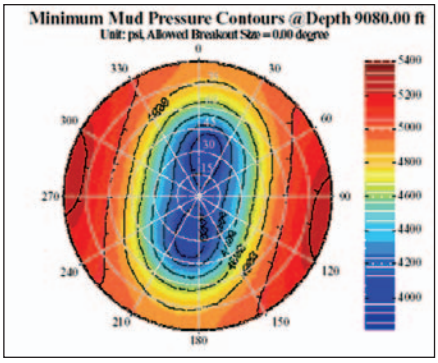
In both examples, dynamic models were used to calculate target surface pressure to keep open hole pressure within narrow margins between fracture and pore pressures.

Models were utilized under several displacement operations. Based on the experience from these operations, the paper discusses in detail how to move to the development of future software tools that make advanced dynamic models more accessible for all kinds of operations.

Successful Field Use of Advanced Dynamic Models (IADC/SPE 99075) KS Bjorkevoll, R Rommetveit, SINTEF Petroleum Research; A Roenneberg, BL Larsen, Statoil.



98787: From a definition perspective, MPD completes a Venn Diagram of advanced drilling technologies as in this figure. In terms of value proposition, each of these technologies possesses a discrete goal but also overlap into each other's domain.



99165: Minimum mud pressure contour for any general wellbore azimuth and direction, at 9080 ft MD.

HOLE-CLEANING IN UBD

This paper is an extended work of SPE 90038. Aerated non-Newtonian flow hydraulics and inclined wellbore section were added to the previous model to study hole-cleaning problems while drilling an underbalanced well. This new mechanistic model for cuttings transport that is developed by combining two phase hydraulic equations, turbulent boundary layer theory and particle transport mechanism, can be useful for predicting cuttings bed thickness and frictional pressure losses at simulated downhole conditions in horizontal and inclined wellbore geometry. Effects of temperature, bottomhole pressure, liquid flow rate, gas injection rate, cuttings size and density, inclination angle and rheology property of drilling mud on hole cleaning are analyzed using this mechanistic model.

Hole-Cleaning During UBD in Horizontal and Inclined Wellbore (IADC/SPE 98926) L Zhou, B Anfinsen, LM Nordeide, AK Rydahl, KC Wade, Scandpower Petroleum Technology.

UBD BOREHOLE STABILITY

A study was conducted in San Joaquin field in Eastern Venezuela to evaluate the feasibility of drilling underbalanced in highly depleted sands interlayered with normally pressured shales.

A geo stress model was developed, including pore pressure model, minimum and maximum horizontal stresses and overburden stress.

Formation rock mechanical properties were obtained using the log data from the field and estimating the more representative static mechanical properties, which were then calibrated with the lab results. The combined geo stress and mechanical properties models were calibrated with respect to drilling-induced fractures and breakouts observed on the image logs.

Instabilities associated with each degree of underbalance were quantified. Contour plots were generated for optimum drilling directions, expected breakouts, required mud weights. Recommendations for efficient drilling were provided.

The results of the study were successfully implemented in the field, resulting in benefits such as reduced lost circulation, improved drilling rate and reduced drilling time and costs.

The results are expected to provide guidelines for underbalanced drilling decisions to be made for future wells in the area.

Underbalanced Drilling Borehole Stability Evaluation and Implementation in Depleted Reservoirs, San Joaquin Field, Eastern Venezuela (IADC/SPE 99165) Baker Atlas; E Guzman, PDVSA.