UNDERBALANCED COIL TUBING

The author will present an update on equipment, technologies, training and personnel requirements in the highly successful underbalanced coiled tubing drilling campaign in the Emirate of Sharjah in the United Arab Emirates. Fourteen wells were completed UBCTD through 24 June 2004 and another 10 were planned. The wells are very challenging with low bottomhole pressures, high temperatures, high vibrations due to the two-phase nitrogen and water drilling mist drilling fluids but extremely successful with high productivity, lowering of nonproductive time, longer sections drilled and as many as seven openhole sidetracks in one well. HSE will also be addressed as this is the guiding theme for an underbalanced operation with over 100,000 feet drilled in the pay while producing gas for sales to local customers.

Underbalanced Coiled Tubing Drilling Update on a Successful Campaign (SPE/IADC 92513-Alternate) **R D Pruitt**, **BP**.

POSITIVE DISPLACEMENT

Latest manufacturing technologies, especially the capability to manufacture pre-contoured stator tubes covered with a thin layer of elastomer, have overcome problems with hydrodynamic turbines. The latest generation high speed mud motors achieve highest bit speeds combined with unmatched torque, resulting in a power output of up to 1,000 hp. These motors can be used in temperatures up to 160°C and have survived numerous runs in excess of several hundred hours of drilling time on bottom without failure.

The authors describe the latest developments in mud motor design and show case histories of motor runs from different vertical and directional wells of different hole sizes in different continents. Special attention is given to an ongoing optimization project that has taken place in close coordination between a motor supplier and an operator in North Germany.

Latest Positive Displacement Motor Developments for Drilling Hard and Abrasive Formations (SPE/IADC 92542-Alternate) **M Reich**, **T Kluth**, **Baker Hughes INTEQ**.

SIMPLE LEVEL 4 WELLS

The authors will introduce a new method for installing a Level 4 junction by detailing the lessons learned from a South American field trial. They will show how standard milling and completion techniques can be used innovatively and reliably to create simple multilateral junctions. In addition, the authors will examine the extensive testing and simulations needed to ensure consistent mainbore access creation while emphasizing installation simplicity. Finally, the field trial will be compared to other Level 4 installations in the region with regard to rig time and the three core capabilities.

Using Proven Milling Technologies and New Methodologies to Create Simple Level 4 Multilateral Wells (SPE/IADC 92606-Alternate) **T M Redlinger**, **A M Pasicznyk**, **Weatherford International**.

Drilling Fluids looks at rock mechanics, sticking

DIFFERENTIAL STICKING

An innovative preventative approach to cure lost circulation when drilling through highly depleted sands has been implemented. The process is based on use of a newly developed deformable colloidal particle that creates an effective bridging at the borehole interface of low permeability sandstone formations.

This new preventative approach with water-base mud has been applied in different fields, while drilling through a series of highly depleted low permeability sands and has proven to be very successful in preventing differential sticking and mud losses.

The authors will highlight a case study using the innovative fluid design to create the particulate bridging and a geomechanical model using field and laboratory data to define the operational limits of various mud weights.

Preventing Differential Sticking and Mud Losses Drilling through Highly Depleted Sands: Fluids and Geomechanics Approach (SPE/IADC 92266) **S Benaissa**, **Baker Hughes INTEQ**; **A Bachelot**, **G Arquery**, **J Ricaud**, **Total**; **X Yi**, **S Ong**, **Baker Atlas**.

ROCK MECHANICS ANALYSIS

The authors will present a working methodology to minimize wellbore stability problems through the use of unique laboratory tests, an experimental database for fluid-rock interaction and acoustic properties of shales, and an integrated modeling approach utilizing different types of experimental and field data. The model simulations provide output accounting for a wide range of input data such as well direction and inclination, mud chemistry, rock mechanical properties, field stresses and pressures, mud temperatures & mud weight, formation anisotropy and shale mineralogy. The model outputs are then used to diagnose field drilling problems or to design drilling operations.

The authors will provide examples to illustrate the methodology and how the analysis may help combat drilling problems and provide a design basis for drilling operations and reduced drilling time.

Drilling Time Reduction Through an Integrated Rock Mechanics Analysis (SPE/IADC 92531) **O Nes**, **E Fjaer**, **J Tronvoll**, **SINTEF Petroleum Research**; **T G Kristiansen**, **BP Amoco Norge**; **P Horsrud**, **Statoil**.

FRACTURE CLOSURE STRESS

In the mid-1990s ExxonMobil developed new operational practices to improve its ability to build wellbore integrity. The author presents the unique rock mechanics perspective that inspired the change, the new operational practices and the improvement in field results. The critical new perspective was that an increase in fracture closure stress (FCS) is required to build wellbore integrity, and not necessarily an increase in tip propagation pressure. The subtle change in focus has had a significant impact on the design and overall effectiveness of lost returns treatments.

Two generalized objectives are established for successful treatments that hold true regardless of the type of treatment used. Successful practices must simultaneously maintain isolation of the fracture tip from wellbore pressure as the fracture is widened, and prop the final fracture width to sustain the increased closing stress permanently.

Over the years, concepts have been developed as to how the various lost returns treatments achieve the two critical objectives and operational practices have been modified to enhance their effectiveness. A direct improvement in

field performance has been observed as a result.

ExxonMobil's worldwide success rate in permeable rock is now close to 100%. However, impermeable rock continues to be a challenge. The author encourages industry efforts to develop products and procedures that achieve the two critical objectives more effectively in low or damaged permeability.

Fracture Closure Stress (FCS) and Lost Returns Practices (SPE/IADC 92192) **F E Dupriest**, **ExxonMobil**.

DRILLING FLUIDS PLANNING

Deepwater drilling is inherently expensive. The choice of drilling fluids and technologies require careful evaluation to diminish commonly observed deepwater challenges such as safety and environmental compliance, hydrate suppression, shallow water flows, logistics, lost circulation mitigation, viscosity profiles and ECD management.

The authors discuss the planning and execution of a drilling fluids program for a world record ultra-deepwater well in 10,011ft (3,051 m) of water in Alaminos Canyon Block 951 in the Gulf of Mexico. The total depth of the well was 22,695 ft (6,917 m) and was successfully drilled using a Gulf of Mexico compliant synthetic-base mud and advanced engineering tools.

Drilling Fluids Planning and Execution for a World Record Water Depth Well (SPE/IADC 92587) **J T Dieffenbaugher**, **R J Dupre**, **G J Authement**, **Y N Gonzalez**, **ChevronTexaco**.

DRILLING OIL SANDS

Drilling heavy oil sands are traditionally fraught with many technical challenges. Wellbore stability, accretion of tar on drill string and solids control equipment, torque-drag considerations and extreme temperature conditions, as well as the handling of oily solids and mud systems are just some of the challenges.

The authors describe the development and testing of a new drilling fluid designed to meet the challenges of drilling heavy oil sands. The water-base fluid is based upon two guiding principals, the ability to incorporate the bitumen into the mud itself, and the capability of the system to later break the bitumen from the mud system.

Data from a six-well horizontal heavy oil program in Northeastern Alberta shows the robustness and effectiveness of the system. The new oil direct emulsion system drilled 1,100 m average horizontal wells 35% faster when compared to conventional inhibition salt technology based drilling fluids.

Development and Field Results of a Unique Drilling Fluid Designed for Heavy Oil Sands Drilling (SPE/IADC 92462) **B K Warren**, **L V Baltoiu**, **Q Max Solutions**; **R G Dyck**, **Remedy Energy Services**.

COMBINED SYSTEMS

Historically, wells in the West Azeri field of the Caspian Sea were drilled with conventional seawater and gel sweeps. However, seawater tended to destabilize the highly reactive formations in surface

Use of a silicate-base drilling fluid in tandem with a unique mud recovery system combined to stabilize a problematic formation in the West Azeri field in the Caspian Sea. SPE/IADC 92769.

intervals, resulting in unacceptable movement of the 20-in. casing. Further examination identified mechanical and chemical destabilization of the reactive soil and Apsheron sandstone formations as the root causes of the instability. The operator conducted laboratory tests to identify possible fluid alternatives that would provide the necessary stability to support the template and casing.

The authors will describe the application of a silicate-base drilling fluid system in tandem with a unique mud recovery system (MRS) that combined to stabilize the problematic formation and allowed for the successful setting of the 20-in. casing without the lateral movement experienced in offset wells. The authors also will examine the development and application of the MRS system that utilized the rig pumps to deliver the fluid down the drill pipe and up the annulus, and specially designed equipment on the sea floor. The latter used a subsea disc pump to transfer the fluid to the surface for conventional solids processing and maintenance. This technique provided a dual gradient to control the equivalent circulating density. Three field tests were conducted to determine the best fluid for use in drilling the surface holes for the operator's template in the West Azeri field. The authors will review and compare the performance of the three field trials.

Silicate-Base Fluid, Mud Recovery System Combine To Stabilize Surface Formations Of Azeri Wells (SPE/IADC 92769) **M S Aston**, **BP Exploration**.

AERATED MUDS

Aerated mud drilling has been recognized to have advantages over conventional drilling fluids such as higher penetration rate, less formation damage, minimized lost circulation and lower drilling cost. Maintaining optimum circulation rates is important in aerated mud drilling operations, however, an applicable prediction of the optimum rates requires accurate modeling of the frictional pressure loss at bottom-hole conditions.

The authors will present a mechanistic model for underbalanced drilling with aerated muds. Extensive experiments in a unique field-scale high pressure and high temperature flow loop were performed to verify the predictions of the model. This flow loop has a 6-in. by 3 ½-in. horizontal annular geometry and is 22 m long.

The hydraulic model determines the flow pattern and predicts frictional pressure losses in a horizontal concentric annulus. The influences of gas/liquid ratio and other flow parameters on the bottomhole pressure and frictional pressure loss are analyzed using this model. Comparisons between the model predictions and experimental measurements show a satisfactory agreement.

Hydraulics of Drilling with Aerated Muds Under Borehole Conditions (SPE/IADC 92484-Alternate) **R M Ahmed**, **S Z Miska**, **N E Takach**, **M Yu**, **A Saasen**, **L Zhou**, **University of Tulsa**.