To cut costs, industry & partners get creative

SOUTH PARS DRILLING

SOUTH PARS, WHERE Norwegian oil company Statoil is technical operator in phases 6, 7 and 8, is part of the world's largest proven offshore gas field. Statoil is responsible for the offshore part of the development. This paper will focus on the planning process and the fit-for-purpose technical solutions that have led to the best overall well times so far in the South Pars field.

The company has surpassed all the previous best drilling and completion times by the other operators in the field and have reduced the total operational time spent on each well to almost half of the original budget estimate of 72 days per well.

Methodical data gathering and mapping of local best practices were incorporated into the planning phase. Improvements that Statoil has introduced to the drilling and completion operations and the technologies and equipment it has used to achieve the success so far will be discussed.

Implementation of Smart Solutions in the Persian Gulf: Optimized Drilling and Completion in South Pars 6-8 (IADC/SPE 99083) B Johannessen, J Vestvik, A Teigen, T Andersen, H Blikra, Statoil.

LOW-COST DRILLING

A two-well low-cost drilling program has been executed to exploit small, undrained oil targets in the Andrew field. The wells have been drilled with 10 percent fewer offshore drilling crew, enabling critical back-to-back inspection and fabric maintenance to continue. Reserves targets have been met and costs reduced by 35 percent.

In 2004, we accepted the challenge to identify and develop these targets and embarked on a three-point program to:

(1) Better define oil targets using 4D seismic and Top Down Reservoir Modelling (TDRM) techniques to address uncertainty;

(2) Minimize offshore drilling support by using an Onshore Operations Centre (OOC). Only 80 beds are available for managing the delivery of all aspects of the business;

(3) Minimize drilling cost through sidetracking, de-scoping and executing preparatory well work prior to full rig mobilization.

The paper will contain a description of the project from planning through execution.

Andrew Low Cost Drilling Teamwork, Technology, and New Working Practices Extend Field Life (IADC/SPE 99069) SJ Sawaryn, R Hassan, LR Bourne, BP; C Telford, C Telford Consultant.

EMERGING DRILLING METHODS

In many offshore regions, drilling problems resulting in narrow margins between collapse (pore) and fracture pressures, pore pressure uncertainty, high pressure and high temperature, and wellbore instability have resulted in significant cost.

Drilling techniques and methods have been developed to mitigate similar drilling problems on land. Most of these techniques and methods can be deployed successfully offshore.

However, with few exceptions, these drilling methods have not been considered for use from floaters, primarily because of the unique differences in equipment required to drill on land and fixed offshore installations compared with drilling from floating rigs.

This paper will discuss the challenges and possible solutions required to cost effectively integrate Emerging Drilling Methods with existing offshore drilling equipment.

Integrating Emerging Drilling Methods From Floating Drilling Rigs Enabling Drilling Solutions for the Future (IADC/SPE 99135) JR Kozicz, TL Juran, Transocean Offshore Deepwater Drilling.

RESCUING A SUNKEN WELL

A 36-in. conductor had been set in 40 m of water on a offshore well jacket. A jack-up rig was being used to drill two new wells through this single conductor.

The first well (Well A) was completed successfully, with a smart completion in a 7-in. liner. The second well (Well B) was under construction. Millions of dollars had been spent. Then the 36-in. conductor sank by 15 inches. 15-in. subsidence was enough to cause a failure of the well under construction (13 3/8-in. casing failed and drill string lost in hole) and severe buckling in the already completed well. 15 in. of movement had potentially rendered the entire operation as non-productive. The 13 3/8-in casing of both wells were cemented into the 36-in. conductor.

This paper describes the thought processes, the engineering and the job execution associated with the successful rescue of this well. Several innovative techniques were used, using coiled tubing, drilling/milling tools, down hole cameras and hydraulic jacks.

Successful Rescue of a Sunken Oil Well With Innovative Coiled Tubing Solution (IADC/SPE 98044) NM Al Araimi, Shell; M Mahajan, LN Portman, BJ Services.

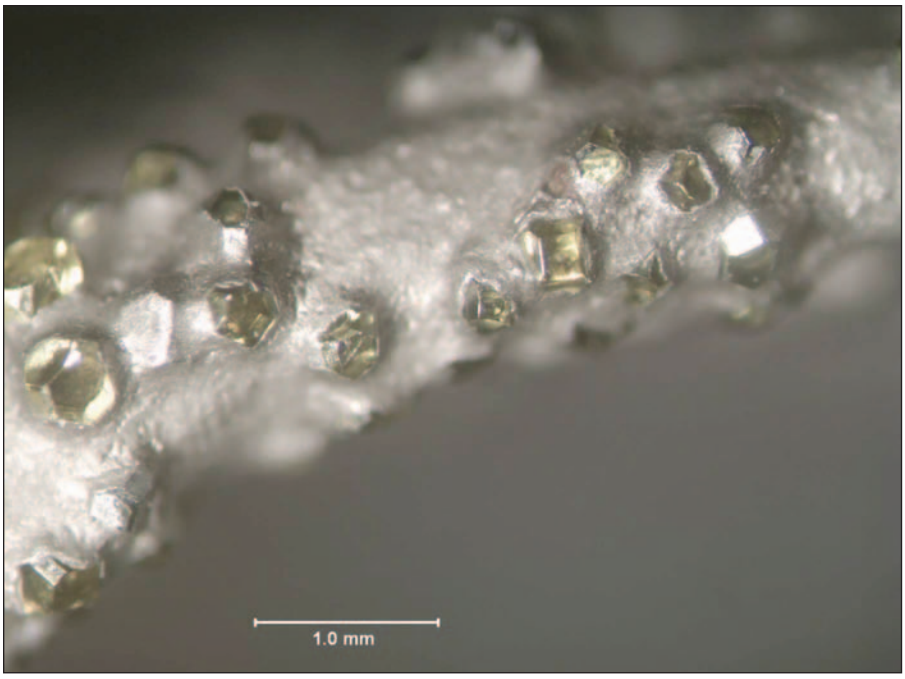
ULTRA-HIGH ROTARY SPEED

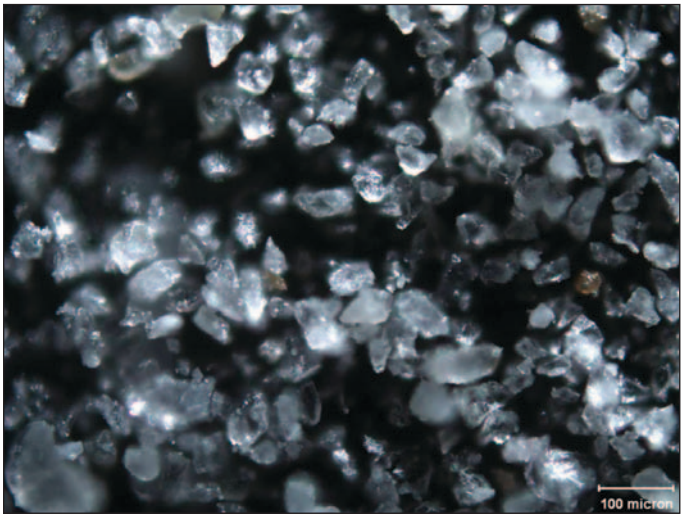
The paper describes testing of an ultra-high rotary speed drilling system and its applicability to hard rock drilling performance. The drilling system includes the use of thin walled diamond product bits driven at extremely high rotary speeds.

Results from this study demonstrate the feasibility, verification and characterization of the system combining high speed and sharp, low depth of cut diamond bits.

Future applications may include slim-hole drilling with downhole electrical, PDM or turbine drives. Adaptation to the oilfield will require innovative bit designs for full hole drilling or continuous coring and the eventual development of these downhole ultra-high speed drives.

The review of industry practices has shown that, in general, rotary speeds above 1,000 RPM have not been used in the drilling of oil and gas wells. Rotary speeds from 1,000 to 50,000 RPM are used to machine or remove hard materials in other applications. These materials are removed efficiently using high RPM and small loads. The drilling and coring industry does not currently practice this technology. The paper presents data and resulting drilling performance





99020: Testing of hard rock drilling performance involving a drilling system that uses thin walled diamond product bits driven at high rotary speeds demonstrates improvement in penetration rates while minimizing expended energy.

of specially designed thin wall diamond core heads tested at bench scale. The results show rates of penetration in different rock types while recording expended energy. Most promising are specific energies that decrease at higher face velocities, possibly showing that rock failure mechanisms change.

Investigation of Smaller Footprint Drilling System; Ultrahigh Rotary Speed Diamond Drilling Has Potential for Reduced Energy Requirements (IADC/SPE 99020) A Judzis, TerraTek Inc; ML Boucher, ReedHycalog; AD Black, JB McCammon, TerraTek Inc.

PMMT ON LARGER MOTORS

Permanent magnet motor technology (PMMT) has been used for many years in small applications such as common hand-held power tools. However, the technology has not been widely implemented on larger-sized motors due to the relatively high cost of producing the permanent magnets. Over the past 4 years, however, this cost has been substantially reduced, and the benefits of PMMT are now economically feasible for larger drilling equipment, such as utility winches, drawworks and top drives.

When using PMMT in winch applications, operational safety is improved upon due to the inherent failsafe electrical braking characteristics in a PMMT. Another PMMT benefit is that the power-to-weight/size ratio is increased by as much as 30 percent compared with a standard induction motor. Permanent magnet motors additionally lend themselves to greater flexibility for high-torque and low-speed applications, thus reducing the need for gear transmissions and, in some cases, eliminating the transmission all together. This simplifies the overall mechanical design and improves the ability to accurately control the equipment than is typically experienced with traditional induction motor drives.

This paper will focus on the opportunities to introduce larger drilling equipment with better performance characteristics related to increased capacities, better control accuracy, enhanced safety due to the PMMT's inherent braking ability, and reduced maintenance as a result of simplified mechanical design.

The paper will also focus on the challenge the drilling industry faces with introducing this new technology due to regulations and standards that have not yet been updated to reflect these changes in design philosophy.

Utilizing Permanent Magnet Motor Technology on Larger Drilling Equipment for Improved Safety and Better Control (IADC/SPE 99078) H Kverneland, MM Moe, G Cervenka, A Austefjord, National Oilwell Varco.

REAL-TIME PROCESS MODELS

The availability of real-time data during drilling operations is increasing, both from surface instruments and downhole gauges. Open standards for real-time data access are used. Computer-controlled drilling machinery like pumps, drawwork and top drive are available. High bandwidth communication between the rig sites and the office, like fiber optic, high bandwidth VHF and satellite, are used. These technologies open new possibilities for monitoring, optimization and control of drilling operations.

A key element in the methodology presented in this paper is that the models for fluid flow and drilling mechanics are continuously updated in real time according to the measured data using Kalman filtering techniques. The flow and mechanical status in the whole of the well may be evaluated, instead of only at the points of measurement. By running an updated model and comparing with real-time data, discrepancies indicating unwanted occurrences can be detected quickly.

Safe limits for the drilling operation are computed and enforced. For example, forward simulations are performed to determine an optimal flowrate build-up curve for start-up of pumps. This optimal curve is used in the programmable logic controller for the pump to achieve opti-

98106 (above): A new method for borehole compensated electromagnetic propagation resistivity logging while drilling (LWD) uses a compact array that is typically 40 percent shorter than conventional antenna arrays for borehole compensated measurements. 99078 (left): Over the past 4 years, the cost of implementing permanent magnet motor technology on larger drilling equipment, such as top drives, has been substantially reduced.

mal flowrate build-up. Also, during the automatic flowrate build-up, real-time pressure monitoring is used to further improve safety.

The modules developed cover tripping, pump start-up, friction tests, stick slip prevention, bit load optimization and monitoring.

The methodology may be applied to drilling operations where the drilling equipment is computer-controlled. It has been tested at a full-scale test rig and against real-time data from offshore drilling operations.

Monitoring and Control of Drilling Utilizing Continuously Updated Process Models (IADC/SPE 99207) EH Vefring, FP Iversen, RF-Rogaland Research; E Cayeux, IPAC A/S; B Mykletun, NOV; A Torsvoll, S Omdal, Statoil; A Merlo, Eni Agip SpA.

RESISTIVITY TOOL

A new method and tool design for borehole compensated electromagnetic propagation resistivity logging while drilling (LWD) are presented. The method provides borehole compensated resistivity measurements at multiple depths of investigation using a shorter antenna array than existing compensation methods. The compact array is typically 40 percent shorter than conventional antenna arrays for borehole compensated measurements, resulting in a shorter, lower-cost bottomhole assembly (BHA). This paper presents the theoretical basis of the compact array design, as well as electromagnetic modeling results demonstrating performance in downhole conditions of interest.

The compact array design has been applied to create a shorter, lower-cost resistivity logging while drilling collar. The three resistivity measurements enable determination of true resistivity (Rt), diameter of invasion, and flushed zone resistivity (Rxo) while drilling, geosteering, and formation evaluation in horizontal or deviated wells where application of wireline tools is difficult. The initial downhole antenna array design is some 44 percent shorter than equivalent conventional antenna arrays for borehole compensated measurements.

Electromagnetic modeling results are presented for the compact array of three receiver and two transmitter antennas, to demonstrate performance of the shallow, medium and deep resistivity outputs from phase difference measurements. Modeling and field test data are used to show equivalent performance of the compact array to existing compensated antenna arrays in rugose boreholes and at bed boundaries.

Modeling results are also presented that demonstrate the limitations and advantages of multi-frequency operation. Test data for a new method for compensation of electronics errors are also shown.

The paper presents a new approach to LWD borehole compensated resistivity methods that reduces the overall length of the antenna array and associated cost.

A Compact Compensated Resistivity Tool for Logging While Drilling (IADC/SPE 98106) DT Macune, WD Flanagan, E Choi, E Marcellus, Ultima Labs Inc.

SAND STUCK TUBING

The reuse of existing wellbores is a critical cost-saving technique in mature oil and gas fields. Older wellbores often require the removal of tubing and packers to allow deepening or side-track drilling. Conventional direct and indirect methods of finding the stuck point(s) along an interval of tubing have proven useful in situations where the tubing is stuck inside casing due to mechanical binding or dehydrated mud. When the sticking is due to uncompacted sand that has entered the annular space between the tubing and casing, these conventional methods are often inconclusive.

Technological advancements in the design and development of slim, 1 11/16-in. OD, radial cement bond tools allow the application of a new measurement in finding stuck tubing points. These tools provide up to six independent, short spaced (18-in.), acoustic attenuation measurements distributed radially around the tool body.

When recorded inside tubing, their increased sensitivity to sound attenuation, as compared with conventional omni directional amplitude signals, allows sand intervals along the outside of the tubing to be distinguished from intervals where little or no sand is present. This information is used to select the best point to sever or back off the tubing.

Detailed examples of applied acoustic technology will be discussed.

The Application of Radial Acoustic Amplitude Signals To Predict Intervals of Sand Stuck Tubing (IADC/SPE 98121) GL Siems, Tetra Applied Technology LP; SP Boudreaux, Bass Enterprises Production Co LP.