

To drill longer wells to reach reserves on the boundaries of the Gullfaks Field required new techniques. The planning of well A-32 C, more than 10 km long, was a challenge where the floating technology where used. The 4,660 m-long, 10 3/4-in. liner was successfully floated to section TD at 7,721 m on 9 May 2006.

The well is the longest well planned and drilled from an offshore installation with a planned TD at 10 km-plus. The simulation in the planning phase indicated it would be very difficult or impossible to run the 5 km, 10 3/4-in. liner to TD with conventional methods. The floatation method was selected for the 10 3/4-in. liner. Simulation showed using floatation and running the liner fully evacuated with air, gave substantial reduction in torque and drag. Using this solution required development of new equipment such as special floats to withstand more than 360 bar differential pressure. Snubbing slips was used to secure liner during running. It took more than a year to plan and prepare this well. The paper describes the planning and obstacles to achieve this challenging goal.

SPE/IADC 105123

The Effect of Hydraulic Vibrations on Initiation of Buckling and Axial Force Transfer for Helically Buckled Pipes at Simulated Horizontal Wellbore Conditions. E.R. Barakat, Chevron; S. Miska and M. Yu, N. Takach, U of Tulsa.

Frictional losses due to contact forces between pipes and wellbore are a primary limitation in extending the reach of many long and high-angle wells. This study investigates a novel technique to reduce the drag forces using hydraulic vibrations induced inside the pipes. Due to pipe dynamics, the contact force will be altered, and therefore the drag friction force will be reduced. The mechanism of drag reduction and the quantitative influence of frequency and amplitude of pulses are not well understood in the drilling industry. Therefore, an experimental study of the effect of hydraulic vibrations on the initiation of buckling and the axial force transfer for helically buckled pipes at simulated horizontal wellbore conditions has been conducted. Results are presented in terms of simple and useful correlations that can be effectively utilized for practical design applications.

SPE/IADC 105068

How Good is the Torque Drag Model? R.F. Mitchell and R. Samuel, Halliburton.

Perhaps the only "standard" drill string model in use today is the torque drag model originally developed by Johanesik in 1984 and put in a standard form by Sheppard in 1987. Because of the simplicity and general availability of this model, it has been used extensively. Why does this model work well in some circumstances yet not so well in other cases? Part of the problem may lie in the description of the wellbore trajectory and the wellbore tortuosity. However, this study concentrates on the actual model formulation. Several example problems with different inclinations and wellbore curvatures are studied to show how these criteria can be used to validate torque drag models.

SPE/IADC 104478

Backing Off a Free Drillstring — Planning and Execution on a World-Class ERD Well. J. Eck-Olsen, Statoil; B.M. Foster, K&M Technology Group.

Since the inception of horizontal and extended reach wells, operators have been faced with the complications that arise when dealing with stuck pipe and pipe recovery options. Drillstring washouts in particular create a tricky situation in ERD operation, as extensive time circulating and rotating at high rates are necessary to sufficiently clean a high-angle wellbore of cuttings to a level that allows a safe and trouble-free trip. When a washout occurs prior to



SPE/IADC 105493: A rotary steerable system and ring gauge pivot stabilizer was systematically tested to enable direct comparisons of the directional response, hole quality and drillstring vibration.

the completion of the cleanup process, the operator is faced with a difficult choice: continue to circulate until the hole is clean, running the risk of enlarging the washout and potentially creating a twistoff, or attempt to pull out of a dirty hole, which may result in tight hole and/or stuck pipe.

A case history is presented where a drillstring washout occurred on a long extended reach well prior to the completion of hole cleanup. Attempts to trip the string quickly proved futile, and it became apparent that the string would either become stuck during attempts to pull. An unconventional application of the backoff technique was safely used to separate the pipe below the washout without the drillstring being physically stuck. The entire string was subsequently recovered, saving more than US\$2 million in lost time and equipment.

SPE/IADC 105558

High-Integrity Wellbore Surveys: Methods for Eliminating Gross Errors. R. Ekseth, K. Kovalenko and J. Weston, Gyrodata; T. Torkildsen, E. Nyrnes, Statoil; A. Brooks, H. Wilson, Baker Hughes INTEQ.

SPE 103734 pointed out the costs of unreliable directional survey data and described how a significant degree of reliability can be achieved with the application of quality control checks internal to the directional data. It also identified the fact that such checks fall short of providing comprehensive reliability assurance.

This paper will document weaknesses in conventional directional survey QC procedures through theoretical considerations, statistical analyses of real survey data, and real examples of failed surveys that have made it through conventional QC procedures without detection. The paper will define principles for survey programme design and implementation to eliminate these weaknesses and propose a new set of minimum requirements for survey validation.

SPE/IADC 104609

Step Changes Needed to Modernise T&D Software. C.J. Mason, BP; D.C. Chen, Halliburton.

Over the past 20 years, while software interfaces have improved significantly, only incremental

improvements have been made to the underlying torque and drag (TD) models. The prevalent T&D mathematical model is based on soft string assumptions pipe stiffness and borehole clearance effects are negligible. Although soft string model is considered appropriate for drill strings, there is uncertainty around its applicability to stiff, heavy casing strings. Several stiff string models have been developed, but their verification is limited.

The first half of this paper will assess limitations of the various stiff string TD models. The second half will define future requirements for what is considered to be the next generation of TD models.

SPE/IADC 105493

Unique Pivot Stabilizer Geometry Advances Directional Efficiency and Borehole Quality with a Specific Rotary Steerable System. S. Barton, A. Clarke and D.G. Perez, ReedHycalog; S. Peach, Weatherford.

The geometry of a stabilizer, when used as a near bit pivot within specific point-the-bit rotary steerable BHAs, is critical to stability and deflection to provide optimal directional response. This paper describes the extensive and systematic testing of a rotary steerable system and ring gauge pivot stabilizer that has enabled a direct comparison of the directional response, hole quality and drillstring vibration to be made for the various combinations tested. The testing also evaluated interaction between the gauge design of the bit and the pivot stabilizer.

Technical Session 6: Deepwater Drilling I

SPE/IADC 105792

More Ultra-Deepwater Drilling Problems. J. Shaughnessy and W. Daugherty, BP; R. Graff, Chevron; T. Durkee, Anardarko.

The industry has pushed the water depth record of ultra-deepwater drilling beyond 10,000 ft and drilling depths below 32,000 ft. A number of new problems have occurred that have been caused by mechanical failures (equipment stressed to its limits) or human error. In the Gulf of Mexico, recent drilling has encountered problems drilling salt. Four operators active in deepwater have collaborated on this paper to document problems under the assumption that understanding what can go wrong is the best way to avoid problems.

SPE/IADC 105914

Deepwater Blowout — A Case History: Shallow Gas Hazards Hide in the Weeds. W. Flores Jr., J.B. Garner and C. Scarborough, Boots & Coots.

This paper will detail the sequence of events involving the blowout of a deepwater development well adjacent to the discovery well, while loop currents prevented running of the BOP stack and riser following the cementing of surface casing. Water depth was 2,400 ft. The cause of the blowout was gas flow after cementing.

The operator designed the exploration well to incorporate the pump and dump process, and successfully drilled riserless through a shallow gas hazard. Surface casing was run and cemented and the #1 well drilled to the objective depth and completed. The #2 well was spud less than 200 ft from the #1 well and duplicated the process.

After circulating lead cement to the mud line and observation of cement returns at the wellhead, a cement slurry was circulated into the well. The drill string was withdrawn and preparations made to run the subsurface stack and riser. However, loop cur-

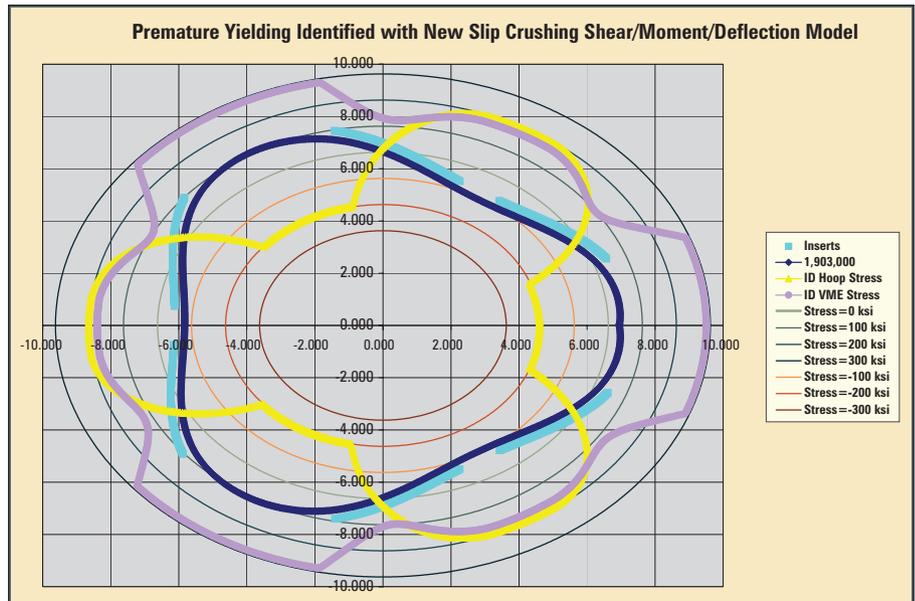
rents developed and prevented the running of any equipment until the currents subsided.

Almost three weeks elapsed before the loop currents abated, at which time the ROV was deployed and discovered the blowout. This presentation will chronicle the extensive effort which the operator expended to re-enter the well, perforate, pump kill mud, confirm that the well was static, and cement. The conclusion, however, is somewhat surprising: Three days dormant after cementing the #2 well, while drilling the replacement well, the #2 blew out again. This presentation will include actual ROV video of the blowout and solutions implemented to successfully drill the replacement well.

SPE/IADC 105619

Encountering an Unexpected Tar Formation in a Deepwater Gulf of Mexico Exploration Well. M.H. Weatherl, Chevron.

Tar formations can present significant challenges during drilling operations. It can prevent the ability to reach total depth, in some cases. These difficulties are compounded in deepwater, where high cost and limited rig availability impact project appraisal and viability. During the second half of 2005 these issues came together for Chevron and partners on the "Big Foot" Prospect in the Gulf of Mexico at Walker Ridge Block 29. An ultra-deepwater drilling unit, the Cajun Express, was mobilized to drill an exploration well to 27,000 ft MD in 5,300 ft of water. This subsalt project was challenging in several respects, including active loop currents and offshore operations in hurricane season in addition to subsurface issues. The focus of this paper will be the unexpected tar formation that was encountered, its effect on the operational strategy, and steps taken to ultimately achieve the well objectives.



SPE/IADC 105628: A comprehensive test program was conducted with 5 sets of deepwater landing string handling equipment with new and conventional technology.

SPE/IADC 105628

Premature Yielding Identified In First Comprehensive 2-million-lb. Deepwater Landing String Test Program. D.W. Bradford, BHP Billiton; M.L. Payne, BP; D.E. Schultz, Nexen; B.A. Adams, Oil & Gas Rental Services; K.D. Vandervort, Mohr Engineering Div.

This paper will present the results of one of the first standardized comprehensive test programs conducted with 5 sets of deepwater landing string handling equipment consisting of both conventional and new unconventional technology. Initial testing at elastic loads approaching yield and final high load testing beyond yield will be detailed. All stages of the test program will be discussed including original testing protocol, test setup, test results, and conclusions.

This presentation is made to identify stress levels associated with the extreme loads that occur when landing very heavy casing strings in deep water wells.

SPE/IADC 105524

The Evolution of a TAML L-4 Multilateral System to Meet the Challenges of a BP Deepwater Subsea Well. K. Horne and R. Allam, BP; M. Glaser and P. Chandler, Weatherford; T. Scharf, Schlumberger.

This paper details the development trials carried out on a multilateral system to meet the needs of drilling and completing a subsea multilateral producer in the North West Area Development (NWAD) of the Schiehallion field, about 175 km west of the Shetland Islands. The selected multilateral system consists of a hollow whipstock, which is perforated through after the completion is installed. The perforating

system was not new technology but still required substantial qualification due to the unique construction of the well. The test programme culminated in a full-scale stack-up of the intelligent completion within a test well followed by the perforating and quantifying of the debris generated and captured.

SPE/IADC 104698

Trapped Annular Pressure — A Spacer Fluid that Shrinks. B. Bloys and M. Gonzalez, Chevron; R. Hermes, Los Alamos National Laboratory; R. Bland, R. Foley and R. Tijerina, Baker Hughes Drilling Fluids; J. Davis and T. Cassel, Baker Oil Tools; J. Daniel, I. Robinson and F. Billings, Lucite International; R. Eley, ICI.

In deepwater and other wells, fluids trapped in casing annuli above the top of cement are heated by

warm produced oil and gas, and thermal expansion can create pressures of 10,000 psi or more, which can cause the collapse of casing and tubing strings. A new mitigation method has created a water-based spacer fluid that will be used just ahead of the cement. The spacer contains 20-25% of emulsified methyl methacrylate monomer (MMA). Upon polymerization, the MMA phase shrinks by 19%, alleviating pressure from thermal expansion.

SPE/IADC 105881

Study of Gelation and Freezing Phenomena of Synthetic Drilling Fluids in Ultra-Deepwater Environments. R.A. Gandelman, R.A.F. Leal, J.T. Gonçalves, A.F.L. Aragão, R.F. Lomba and A.L. Martins, Petrobras.

Linear paraffin-based invert emulsions are frequently used as non-aqueous drilling muds offshore Brazil. Fast and non-progressive gelation is desired to prevent drilled solids sedimentation during pumps off while avoiding excessive pressure peaks when circulation is resumed. Gelation tendencies are normally higher at low temperatures typical of deepwater risers. Additionally, excessive pressures and/or difficulties to resume circulation have been observed drilling in water depths greater than 1,800 m.

The paper shows the results of an experimental study to evaluate the rheological behavior and gelation properties of non-aqueous drilling muds below 4°C and pressures up to 5,000 psi. The study aimed to quantify pressure effects on freezing temperatures and to develop representative methodologies for the evaluation of thixotropic properties of such fluids.

Technical Session 7: Bit Technology

SPE/IADC 105017

Development and Utilization of a Bit-Based Data Acquisition System in Hard Rock PDC Applications. P. Pastusek, E. Sullivan and T. Harris, Hughes Christensen.

Drill bits are iteratively developed to meet performance objectives such as aggressiveness, durability, stability, steerability, etc. The transition from one iteration to the next occurs when dull bits are examined, run data is analyzed and the inferences are implemented as revisions to the bit design and/or the operating parameters. Experience shows that the efficiency of the process depends on the appropriateness and significance of the data collected.

One way to improve the significance of the data is to implement a special-purpose data acquisition system within the bit. The paper describes an effort to develop, validate and utilize a bit-based module designed to monitor accelerometer and magnetometer sensors and to record selected data.

SPE/IADC 104388

Successful PDC/RSS Vibration Management Using Innovative Depth-of-Cut Control Technology: Panna Field, Offshore India. A. Jaggi and S. Upadhaya, BG India; A.R. Chowdhury, Hughes Christensen.

The operator has been active in the Panna Field for several years drilling a main horizontal and 2 laterals through a window milled in pre-existing 9 5/8-in. casing. Initially, the operator used RSS/MWD to geosteer the BHA to the target formation. However, previously chosen PDC bits were causing severe lateral vibrations, stick slip and BHA whirl, resulting in multiple downhole tool failures. An in-depth study revealed the BHA was exposed to severe stick slip and lateral vibrations. There were also regular