Directional drilling headed for improvements

TORQUE REDUCTION

NINE TO 11 km reach world-class ERD wells are used in the Russian Far East to develop an offshore reservoir from an onshore location. While drilling initial wells into the reservoir, high torque was experienced, even while using a non-aqueous drilling fluid. The torque was sufficiently high that concerns arose about the feasibility to drill longer wells. Consequently, finding techniques to reduce drilling torque became a major focus for the development.

A systematic R&D process was initiated to solve the torque problem. The scope of the investigations included consideration of different base oils, solid/liquid lubricants and mechanical means to reduce torque. Small-scale screening lubricity testing was performed in a controlled laboratory environment to identify potential lubricant candidates. Full-sized laboratory testing was then performed on the leading products. Various mechanical means to reduce torque were also evaluated. Finally, field trials were performed using solid and liquid lubricants and different types of mechanical torque reduction tools.

Solid lubricants caused issues with BHA components and their use was discontinued. Liquid lubricants achieved torque reductions of 5 percent to 15 percent, which was sufficient to drill the longest throw wells. The mechanical tools added to the drillstring were found to have drawbacks related to the durability of the tools or the achieved torque reduction. Both mechanical and lubricant solutions represented a significant addition to the overall cost of the wells. Eventually, the use of 4,500 m range II drillpipe caused an immediate 30 percent to 35 percent drop in torque. Further evidence that the large contact area between the casing and the range III drillpipe is causing both excessive wear and torque was provided when DP inspections revealed an alarming increase in rejections due to excessive tube wear.

Ongoing investigations attempt to find mechanical solutions to the drillpipe casing contact problem. While new orders of drillpipe will be range II pipe, the existing large inventory of range III drillpipe needs to be protected from excessive wear, while at the same time reducing the drilling torque. Several types of DP centralizers are under investigation and may represent a viable solution to both problems.

Torque Reduction Techniques in ERD Wells (IADC/SPE 98969) JH Schamp, BL Estes, SR Keller, WJ Thomas, ExxonMobil.

CATENARY WELL PROFILE

This paper presents analysis and design of ultra-long wells using a catenary well profile.

The paper presents results from a research program that was undertaken to define the limits and the potential for ultra-long wells. A major part of the research is the development of a complete catenary model for design of wellpath, drill pipe loads and torque and drag forces. The new model is analytically exact, but it is simplified by replacing the hyperbolic functions with ordinary trigonometric functions. The paper will present a procedure to compute the well path and forces, in addition to a worked example of a catenary well, such that anyone can construct these wellpaths using a spreadsheet.

Standard and undersection build profiles are compared with several catenary profiles. It is shown that the only way to limit the torque is by applying a catenary profile. Furthermore, various well operations are investigated. Ten, 12 and 16 km horizontal departure wells are compared. One of the findings is that there is an optimum length and shape of the catenary from the kick-off point to the sail section, where well friction is at a minimum.

The study shows that a 16 km horizontal departure well can be drilled with ordinary drillpipes by using a catenary profile. A comparison with other pipe materials is provided.

Other limitations to ultra-long wells are also addressed, such as hydraulics, casing seat location and borehole stability issues. The paper presents a proposed drill string design for ultra-long wells.

The proposed paper is significant for the evolution of ultra-long wells. The complete method basis for the catenary is not published earlier, and, with the worked examples, it will provide an important tool to plan these wells.

Construction of Ultralong Wells Using a Catenary Well Profile (IADC/SPE 98890) BS Aadnoy, V Toff, J Djurhuus, University of Stavanger.

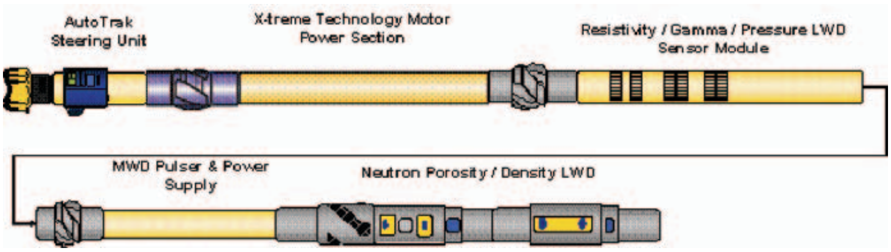
HIGH ANGLE CASING

Producing more than 10,000 bbl of fluid from high angle or extended reach wells is a rough benchmark for making these wells profitable offshore. This means using a 5-in. production string and something different from the standard 13 3/8-in., 9 5/8-in. and 7-in. intermediate strings. While this has been discussed for several years, the application of casing while drilling to offshore directional wells makes it time to implement a change. The use of 10-in. and 7 5/8-in. intermediate strings in higher production ERD wells will be more efficient for both casing directionally drilled wells and standard drill pipe wells.

This paper discusses the design and testing of 10-in. and 7 5/8-in. casing directional drilling equipment and procedures that ConocoPhillips plans to use in mature North Sea fields. ConocoPhillips has worked with Petrobras, Tesco Corp and Schlumberger in building drill lock assemblies (DLAs), under reamers, positive displacement motors, MWD tools, rotary steerable systems, and high-capacity winches for this work. Testing this equipment in commercial North Sea operations is prohibitively expensive. Tests were conducted at a drilling test facility near Cameron, Texas.

This allowed for operations over a wide range of RPM, weight and flow conditions, as well as inclinations from vertical to horizontal. High frequency surface and downhole drilling mechanics measurements were made and allowed for diagnosing problems and improving the systems. The project also serves as a blueprint for managing technical developments among multiple operator and service companies.

Designing High Angle Casing Directionally Drilled Wells With Fit for Purpose String Sizes (IADC/SPE 99248) WG Lesso, Schlumberger; RD Watts, ConocoPhillips; TM Warren, Tesco Corp; BM Borland, ConocoPhillips.



98471: With a rotary steerable system that integrates a performance drilling motor with a high-speed rotary steerable tool, plus the latest steerable drill bit technology, precise 3D trajectories can be drilled at more than double the offset rates of penetration.

CENTRAL NORTH SEA DRILLING

The Central North Sea (CNS) Cretaceous formations are notoriously difficult for performing directional drilling operations. Oriented-drilling using bent housing steerable motors is troublesome, and rate of penetration is unacceptably slow with rotary steerable systems. This has historically resulted in well trajectories being planned with minimal directional course changes through these sequences and, when directional course changes are absolutely required, oil-based mud is often required to facilitate oriented drilling. With many assets in the Central North Sea reaching maturity, directional drilling course changes in the Cretaceous has increasingly become a necessity to access remaining targets.

Talisman Energy (UK) Limited acquired several CNS mature assets in 1997-2005. A challenge was to improve directional drilling control and overall drilling performance through the CNS Cretaceous while moving away from oil-based mud requirements. A new-generation rotary steerable system, which integrates a performance drilling motor with a high speed rotary steerable tool, was introduced to meet this challenge.

By applying this new system, coupled with the latest steerable drill bit technology, precise three-dimensional trajectories are being drilled at more than double the offset rates of penetration, and water-based mud can be used more frequently. The results have been easier access to remaining reserves, a dramatic reduction in drilling time, lower environmental impact and overall reduced cost and risk. This paper describes the drilling conditions in the CNS and the new drilling technology applied. It also describes the challenges encountered applying new technology on cost-sensitive mature assets, procedures put in place to minimize operational risk while introducing the new system and a comparison of performance now compared with that of offset wells.

Introduction of New Drilling Technology Improves Performance of Mature Central North Sea Assets (IADC/SPE 98471) JP Ruszka, Baker Hughes.

SCORING WELLBORE QUALITY

Wellbore quality is not well-defined and frequently misunderstood. Moreover, operators are not in the business of drilling geometrically perfect wellbores but in drilling cost-effective, fit-for-purpose wells that meet safety, directional and reservoir objectives. Thus, the Wellbore Quality Scorecard (WQS) has been developed to provide a consistent and flexible rating of wellbore quality.

The WQS includes ratings based on three measured responses:

1. Drilling response (D): to provide a limited measure of wellbore quality;

2. Final trip out of hole response prior to casing running (T): to provide a better measure of wellbore quality;

3. Casing running response (C): to provide a final and most critical measure of wellbore quality.

The WQS is broken down into its components, such as D4T4C5 represents a WQS of 13. A WQS of 0 represents the worst possible wellbore quality. A WQS of 20 is the highest score. It is intended that the rating of an earlier response will impact a later response. For example, the drilling response rating could help to choose the method of hole preparation. And the final trip out of hole response rating is a good indication of if the wellbore is fit-for-purpose to run casing.

This paper will provide guidelines on how to calculate WQS and its applications in field cases from BP worldwide operations. The paper will also show the correlation between the WQS and drilling and completion costs.

Adoption of a WQS system should encourage operators, drilling contractors, directional drillers, mud companies and other key personnel to become better acquainted with all aspects of wellbore quality.

The Wellbore Quality Scorecard (WQS) (IADC/SPE 98893) DC Chen, Halliburton; CJ Mason, BP.

BHA VIBRATION MODELING

Wells in the Ringhorne Development, offshore Norway, usually kick off below 26 in. conductor with 17 1/2-in. hole building angle from vertical to 65 degrees where 13 3/8-in. surface casing is installed. As the development has progressed, there is requirement for upsized casing program with 18 5/8-in. surface casing and hence, to build 24-in. deviated hole from 300 m MD to approximately 70 degrees by 1,000m MD and section TD at approximately 1,600m MD (1,100mTVD).

The first 24-in. section was drilled using a rotary steerable BHA with a PDC hole opener. However, vibration problems caused a tool failure. This led to angle dropping and early section TD. The next 24-in. section was drilled using a two-run strategy, including 17 1/2-in. rotary steerable assembly to TD before picking up a 24-in. hole opener in a separate run. The first HO run twisted off after drilling into the massive Utsira sandstone, and the following three HO runs were pulled due to poor performance causing casing to be set high.

Due to the complexity of the well, no deviation from the well path could be tolerated, and the casing shoe had to reach the planned depth. Time and depth-based data, formation data and vibration measurements from the previous runs were evaluated, and various BHAs were analyzed for stability. This investigation led to a stable BHA configuration, selection of optimum bit properties, recommendation for parameter combinations and response plans for the drilling of the different formations encountered. A plan was developed that focused on drilling practices and parameter adjustments according to the formation.

The result was reduced vibration, enabling the crew to follow the well path

Planning and Detailed BHA Vibration Modeling Lead to Performance Step Change Drilling Deviated 24-in Hole Section, Offshore Norway (IADC/SPE 99126) CC Elsborg, ExxonMobil; G Grindhaug, Baker Hughes.