Foam Cementing on the Eldfisk Field - Case Study (SPE/IADC 79912) by **K M Green**, **P G Johnson**, **Phillips Petroleum**; **R Hobberstad**, **Halliburton**.

CEMENT EXPANSION

Ongoing problems with sustained annular gas pressure on producing wells worldwide is a prime indicator that more work is needed in understanding how cement system design can impact long-term annular isolation. One important area is the relative expansion or shrinkage of cement systems as they hydrate in the annulus of a well.

The authors detail new methodology and test equipment that allows for the tracking of cement shrinkage and/or expansion real-time, under downhole conditions of pressure and temperature.

Real-Time Cement Expansion/Shrinkage Testing Under Downhole Conditions for Enhanced Annular Isolation (SPE/IADC 79911 - Alternate) by **V C Gobancan**, **R L Dillenbeck**, **BJ Services Co**.

FORMATION STABILITY

Managing formation stability should be an integral part of well construction from drilling through cementing and completion operations. Formation stability while drilling has been recognized and is an ongoing study in the petroleum industry. Given a stable wellbore at the end of the drilling phase, if the cement and space properties are not optimized then the formation could be de-stabilized during cementing. This could adversely impact the well construction and subsequently the well productivity.

Understanding Formation (In) Stability During Cementing (SPE/IADC 79913 - Alternate) by **K Ravi**, **U Tore**, **J Heathman**, **Halliburton Energy Services**.

Directional drilling technology reaching new lengths

CASING DIRECTIONAL DRILLING

Growing commercial activity indicates increasing acceptance of drilling with casing to reduce drilling costs and solve drilling problems. Most of this activity has been focused on drilling vertical intervals, but interest in drilling with casing in directional wells is increasing as the processes for drilling straight holes become proven and more versatile tools become available.

The Tesco Directional Casing Drilling system wireline retrievable directional drilling assembly, positioned in the lower end of the casing, replaces the directional tools used in a conventional BHA.

These tools have been retrieved and rerun at inclinations exceeding 90 degrees. The casing can be reciprocated and circulation maintained while running or retrieving the tools to assure that the casing does not become stuck.

The authors will provide a description of the tools that are used for directional drilling with casing; show Casing Drilling results for both low angle and high angle wells; discuss BHA selection for use with Casing Drilling operations; and show the viability and advantages of Casing Drilling in directional wells.

Directional Drilling with Casing (SPE/IADC 79914) by **T M Warren**, **G Modell, B Houtchens**, **Tesco Corp.**

AZIMUTH AND INCLINATION

An alternative technical solution introducing the ability to control both azimuth and inclination through standard rotary BHA is discussed. It is based on a patented principle consisting of the ability to master bit and BHA walk-tendencies, through 'down-hole friction management', at the level of a given stabilizer. An innovative technical solution is proposed, through a simple and fully mechanical stabilizer combining variable blade and 'clutchable' non-rotating sleeve.

This large-hole rotary steerable system was designed, tested and deployed by BP and Schlumberger over a period of nine months.

A group of companies, led by TotalFinaElf, has enabled the design, construct and field-test of a prototype of a new tool called 'Gyrostab' which has demonstrated the new trajectory control principles and potentials.

Gyrostab Project "The Missing Link": Mastering Azimuth and Inclination Through New Principles Adapted to Standard Rotary BHAs (SPE/IADC 79915) by **J M Genevois**, **TotalFinaElf**; **J G Boulet**, **SMF International**; **C J A Simon**, **Drillscan**.

ROTARY STEERABLE SYSTEM

A successful introduction and application of a rotary steerable system for large hole sizes (17 1/2-in. and 18 1/4-in. in.) is described. BP and Schlumberger created and deployed this new capability while working on a major development project. Together, they focused on the rapid acceleration, construction, and field testing of the rotary steerable system.

Over a period of nine months, the rotary steerable system was designed, tested, and deployed by teams working concurrently in the UK and the USA. Initial field trials proved successful with the system achieving the required kickoff from vertical of more than 3°/100 ft buildup rate.

Development and Application of a Large-Hole Rotary Steerable System: Accelerating New Technology Introduction Through Successful Collaboration (SPE/IADC 79916) by **K Armagost**, **BP**; **D Pafitis, M Wernig**, **Schlumberger**.

DIRECTION AND INCLINATION

The measurement of continuous real-time inclination provides near instantaneous calculations of build-up rate tendency of the bottomhole assembly in both rotary and slide drilling modes. The addition of an accurate azimuthal measurement now allows for the calculation of wellbore position with this continuous data. When wellbore position is calculated with the continuous surveys a significant discrepancy from the stationary surveys can occur.

The paper highlights the results of field studies and demonstrates methods for maximizing positional accuracy. A low cost solution for effectively determining when to slide and rotate with respect to the stationary survey is presented.

Continuous Direction and Inclination Measurements Lead to an Improvement in Wellbore Positional Accuracy (SPE/IADC 79917) by **W G Lesso Jr**, **Schlumberger**; **E J Stockhausen**, **ChevronTexaco**.

REAL-TIME BHA BENDING

The Troll reservoir in the Norwegian North Sea consists of loose sands and local hard calcite cemented zones. It is exploited with long horizontal reservoir sections of up to 3,200m in length.

A new downhole dynamics tool, positioned above the rotary steerable system, is capable of measuring the bending moments in the BHA generated by side forces at the bit. If transmitted to the surface while drilling, the BHA bending information allows early detection and quantification of local doglegs independent of their orientation. The driller can then reduce the dogleg severity by reaming the section.

Real-time BHA Bending Information Reduces Risk when Drilling Hard Interbedded Formations (SPE/IADC 79918) by **J A Hood, G Helsig**, **Baker Hughes INTEQ**; **J Hovden**, **Norsk Hydro**; **K D Ernesti**, **Baker Hughes INTEQ**; **A Knipper**, **Baker Hughes Oasis**.

REDUCED TORQUE AND DRAG

Torque and drag can be critical issues in drilling directional wells especially in extended-reach drilling (ERD). During well planning, torque and drag must be projected to ensure the rig's rotating and hoisting equipment are adequately-sized and to evaluate the limits for slide-oriented drilling motors. Depending on formations, typical open hole friction factors used in the simulation range from 0.22 in oil-based mud to 0.35 in water-based mud.

The paper presents a friction factor study for the wells drilled in the North Sea. Using the stiff-string torque and drag model, friction factors are back calculated from the field data run by the conventional motor systems and by the new drilling systems that utilize extended gauge bits.

New Drilling Technology Reduces Torque and Drag by Drilling a Smooth and Straight Wellbore (SPE/IADC 79919) by **D Stuart**, **Peak Well Management**; **D C-K Chen**, **D Hamer**, **T Gaynor, C Henderson**, **Halliburton**.

BHA OPTIMIZATION

Petro-Canada has realized that spiral hole is a limiting factor to optimized wellbore construction in the Terra Nova Field offshore Eastern Canada. The operator is actively pursuing technology solutions to reduce cyclic borehole effects in wellbore construction. Although spiral borehole is common, it's rarely addressed because most drilling engineers do not view it as a limiting factor in wellbore design.

The authors will discuss and document the economic benefits of eliminating spiral hole. They will demonstrate how different steerable motor BHA configurations and motor types affect spiral hole in Terra Nova Field. The increased hole quality cut drilling costs and total cost by C$3,402,OOO per well, including an 8.95 decrease in days per well and a 117% increase in ROP.

BHA Optimization Reduces Spiral Hole Effects and Cuts Drilling Costs, Offshore Eastern Canada (SPE/IADC 79920 - Alternate) by **J Evans**, **Petro-Canada**; **J Dillon**, **J Beresford**, **Baker Hughes**.

ROTARY STEERABLE SYSTEM

The availability of a reliable 3D rotary steerable system in 6-in. hole size opens up considerable opportunities to develop reserves where 3D steering is required. However, the risks, difficulties, and delays involved in using bent housing mud motors are excessive.

On 10 April 2002, parallel field trials of a 3D, 6-in. rotary steerable system started in Oman and the North Sea. The field trials program finished in June with more than 16,000 ft drilled and more than 400 circulating hours experience accumulated in a range of formations without failure. During these trials, the tool displayed steerability and dogleg performance ideally suited to landing and geosteering a well in the reservoir section.

Rotary Steerable Drilling System for the 6-in. Hole Size (SPE/IADC 79922 - Alternate) by **G C Downton**, **D S Carrington**, **Schlumberger.**

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