Reservoir targets reached with directional drilling

ROTARY STEERABLE DRILLING

THE RINGHORNE PLATFORM in the Norwegian North Sea is a challenging extended reach development with 24 wells planned within an 8 km radius of the platform surface location. The main challenges are locating thin sands far from the platform and optimally placing long and complex horizontals into those sands.

The author will describe the challenges, solutions, and technology applications for drilling and positioning Ringhorne directionally complex wells into thin, complex sands. The concept of a Multi Penetration Pilot (MPP) was proposed to increase the number of reservoir penetrations. By drilling an undulating pilot multiple times through the top and bottom of the reservoir with LWD, sand mapping would be substantially improved, thereby reducing geologic risk of the prospect.

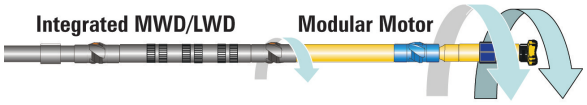
Conventional pilot holes had been used in Esso Norway to locate reservoirs; however, continued geologic uncertainty coupled with thin sands further away from the pilot hole precluded positioning long horizontals. Keys to success include identifying and mitigating increased risks in regards to greater lost circulation potential, wellbore instability, hole cleaning challenges, and directional control problems.

Benefits and risks of the MPP versus a conventional pilot will be discussed, as a conventional pilot would not have located sand in the first two wells where the MPP was utilized. The MPP also optimally placed the 9?5/8-in. casing shoe and enabled the reservoir engineers to locate the horizontal in the most desirable location in the sand. The MPP achieved its primary purpose of assisting Geology with locating the tops and bottoms of the reservoir section. This concept saved at least two pilot hole sidetracks.

Rotary Steerable Capabilities To Locate Thin, Complex Sands (SPE/IADC 92152) **A H Lee**, **ExxonMobil**.

INTEGRATING DRILLING

A system has been developed which integrates a specially designed high power drilling motor within a high speed rotary steering assembly. By using this new system many of the challenges of continuous rotary drilling are mitigated, more complex wells benefit from the advantages of traditional performance drilling, and existing drilling envelopes can be extended to further improve field recovery. The authors will discuss the engineering design of the complete system, including the specially designed motor and high speed rotary steering system. They will also discuss specific applications where the system should be considered for use, illustrated with results from real wells.



Many of the challenges of continuous rotary drilling are mitigated with a specially designed high power motor within a high speed rotary steering assembly. SPE/IADC 91810.

Integration of a Performance Drilling Motor and a Rotary Steerable System Combines Benefits of Both Drilling Methods and Extends Drilling Envelopes (SPE/IADC 91810) **J P Ruszka**, **R Grosspietsch**, **Baker Hughes INTEQ**; **H Ronnau, P V Balslev**, **Maersk Oil & Gas**.

LOW COST ROTARY STEERING

The benefits of continuous rotary drilling in directional wells through application of 3D Rotary Steering Systems (3D RSS) are well documented in the industry. ExxonMobil Development Company (EMDC) continues to expand the application of these systems where economic incentive exists. The strategy is intended to accelerate the development of low-cost 3D RSS to capture benefits of this technology to improve drilling performance and economics in lower-margin projects.

Systematic usage of the tools in various modes (maintaining verticality, building angle, and holding angle and azimuth in tangent sections) have given the providers valuable real world testing to validate and improve tool design and to improve reliability of components. The performance realized from applying this technology at its current level of development and an assessment of its value to EMDC will also be discussed.

Field Application in the Development of Low-Cost 3D Rotary Steerable Systems (SPE/IADC 92035) **W T Burnett**, **J T Travis**, **ExxonMobil**; **J G Samuell**, **Noble Downhole Technology**.

CASING DRILLING

The combination of rotary steerable system capabilities with casing drilling operations seemed like a natural solution to directional casing drilling problems. Two weaknesses in motor BHA designs are eliminated. First, an undersized motor is required to turn both the underreamer and bit. Second, full gauge stabilization above the motor for directional contact control cannot be done. Rotary steerable systems have not been applied in casing drilling because both are new technologies used in different environments. Casing drilling was developed on land operations while rotary steerables have been popular for offshore projects.

ConocoPhillips has casing drilled more than 80 wells in the Lobo trend since 2001. Two wells were drilled utilizing Schlumberger's PowerDrive rotary steerable system. The first was an operational test. The tool was run in verticality mode.

The second well called for a build to 25° and then to drop back to vertical. Both operations took place in the 7-in. casing section where a 6 1/8-in. pilot hole was directionally controlled and opened to 8 7/8-in. The authors discuss the drilling of the first two wells to utilize a rotary steerable system in ConocoPhillips' Lobo casing drilling project near Laredo, Texas.

Casing Directional Drilling Using a Rotary Steerable System (SPE/IADC 92195) **W G Lesso**, **Schlumberger**; **T J Mushovic**, **ConocoPhillips**; **T M Warren**, **Tesco Corporation**.

SLIDING TECHNOLOGY

Sliding technology allows for full steerability while slide drilling using a motor/MWD system and a top drive by rocking the pipe to the right and left automatically by an amount that maintains tool face constant while optimizing

sliding average ROP. The authors describe its use in the field and present field results that prove the viability of the technology. They will describe all the elements that were needed to successfully obtain the desired trajectory change when sliding using a motor steerable system and a top drive.

Field Proof of the New Sliding Technology for Directional Drilling (SPE/IADC 92558) **E E Maidla**, **M Haci**, **Slider**; **T M Warren**, **Tesco Corporation**.

WELL COLLISION AVOIDANCE

A new method is proposed that retains existing rules for avoidance of shallow (severe outcome) collisions and provides the option for use of risk-based rules in deeper sections of wells where the outcome of a collision would not be as severe. Different to previous studies using risk based approaches, this method utilizes a geometrical solution to the well collision risk problem that takes into account the angle of convergence, known to a high degree of certainty even at the planning stage. The risk level of collision with respect to any offset well is calculated and then converted to a Separation Factor, an established standard for evaluating different levels of collision tolerance in wells.

Implementation of a New Risk Based Well Collision Avoidance Method (SPE/IADC 92554-Alternate) **G A McNair**, **ChevronTexaco**; **S J Lance**, **Chevron Overseas Petroleum**; **J M Codling**, **Landmark Graphics**.

TORTUOSITY FACTORS

Tortuosity is one of the critical factors to be considered for complex directional well trajectories, complicated build rates, precise steering in thin reservoirs and extended reach wells. When planning a well, wellpath modeling commonly generates smooth curves, whereas actual wells contain severe doglegs and other irregularities. Determining tortuosity factors to apply in the well path is always a challenge during the planning phase. No quantification method is presently available. Field tests have shown that the present calculations gravely underestimate the drillstring torque and drag values for highly deviated, tortuous deep wells.

Calibration of Tortuosity Factors for Highly Tortuous Wells: A Practical Approach (SPE/IADC 92565-Alternate) **R Samuel**, **Landmark Graphics**.