As RSS tools evolve, so should bit designs

BIT DESIGN FOR RSS

NORTH SEA FIELDS continue to benefit from improvements in PDC bit and rotary steerable technology. There are, however, issues relating to very hard imbedded formations that result in stick-slip, bit/BHA wear, shocks/vibration, tool failures and short run lengths.

Rotary steerable systems (RSS) are essential to drill the tortuous well paths. Push-the-bit RSS tools, first employed with early versions of point-the-bit systems, resulted in premature tool failures. Tool modifications, increasing their ruggedness, led to longer runs, and new point-the-bit systems have reduced shocks/vibrations, allowing more tolerance of the harsh drilling environment.

There has been an evolution in cutter technology/bit design. The cutters have higher wear resistance and are able to drill formations that were previously not PDC-drillable. Bit designs evolved as RSS tools have changed: point-the bit versus push-the-bit systems. The new point-the-bit systems require modifications to bit gauge designs. High stick slip and vibration are the main constraints to performance but are greatly reduced by designing the bit to complement the RSS.

This paper will show how modifications to bit designs based on the steering characteristics of RSS tools, and modifications to operating parameters of the RSS tools based on the characteristics of PDC bits, have been brought together to yield a significant improvement in drilling performance.

A New Approach to Stick Slip Management Integrating Bit Design and Rotary Steerable System Characteristics (IADC/SPE 98962) MR Niznik, AD Carson, ExxonMobil; KJ Wise, Schlumberger; F Carson, Reed Hycalog.

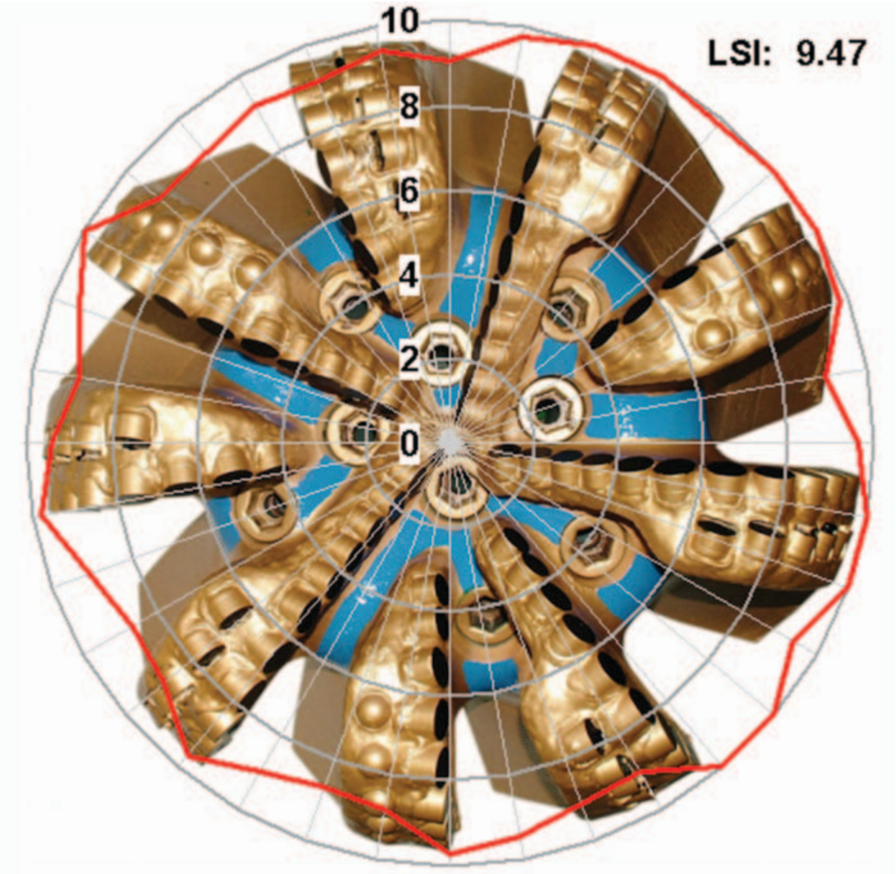
TWO-CONE BITS

Designers have always recognized great advantages in two-cone bits, which have not fully lived up to their potential. There has always been concerns with vibration, directional responsiveness, hole straightness, mechanical reliability and hole cleaning, leading to their displacement by three-cone bits.

But technology advances have encouraged bit manufacturers to revisit older designs.

To date, six runs with a modern two-cone bit design have taken place in the Texas and Louisiana Gulf coast. All runs are reported in this paper, detailing lessons learned and successes from the new two-cone bit that have been shared by the operators.

Unlocking Two Cone Bit Potential: Technology, People, and Planning Make It Possible and the Lessons Learned (IADC/SPE 99017) PK Centala, Smith Bits; RJ Ford, Smith Tool; TL Dunn, Ballard Exploration; T Burnett, MM Burley, Smith Bits; JP Sinesi, Smith International Inc.



98986: Traditionally, attempts to design laterally stable PDC bits have assumed that the forces generated by the bit cause it to begin whirling. A new approach assumes that it is the response of the bit to force motion off its center that causes whirl. A test in the Northwest US validated the method.

LATERALLY STABLE PDC BITS

Bit whirl is well-documented as a major cause of damage to PDC drill bits, resulting in short runs, low ROP, high cost/ft, poor hole quality and downhole tool damage. Hence, consistent lateral stability is highly desirable in PDC bits.

This paper presents a new method of producing PDC drill bits that reduce or eliminate bit whirl. Traditionally, attempts to design laterally stable PDC bits have assumed that the forces generated by the bit cause it to begin whirling. This new approach assumes that it is the response of the bit to force motion off its center that causes whirl.

This new method was successfully validated through a field test program in the Northwest US.

This paper demonstrates how the use of this new method can eliminate whirl in both laboratory and field environments and deliver significant performance improvements over traditional force balancing methods.

A New Method of Producing Laterally Stable PDC Drill Bits (IADC/SPE 98986) SC Johnson, ReedHycalog.

GAGE PAD DESIGNS

Although several factors affect overall bit performance, this paper will isolate the contributions of gage pad design as they relate to the functionality, dynamic behavior and performance of the different rotary steerable tool types: push-the-bit and point-the-bit. It will discuss the effects of gage pad length, geometry and activity (side cutting) when all other bit factors are held constant.

Extensive field data having different gage configurations and in similar applications will be presented.

Gage Design Effects of Gage Pad Length, Geometry and Activity (Side Cutting) on PDC Bit Stability, Steerability, and Borehole Quality in Rotary Steerable Drilling Applications (IADC/SPE 98931) G Mensa-Wilmot, B James, Smith Bits; L Aggarwal, H Luu, Schlumberger; F Rueda, BP.

DRILLING SIMULATORS

This paper describes how the use of a full-size, real-time drilling simulator can significantly reduce the learning curve for operations.

Techniques such as Through Tubing Rotary Drilling (TTRD) and Extended Reach Drilling are still typically new to many of the field drillcrews involved.

Traditionally used for well-control training or the training of crews to operate new-generation automated drilling equipment, drilling simulators are also now being used to practice techniques in a low-cost environment.

This paper describes how state-of-the-art simulators can be programmed to realistically model the proposed operation.

The paper explains how well planners can then identify whether certain aspects of their programs are effective and establish whether all anticipated eventualities have been covered.

The paper concludes that the use of such facilities has significantly accelerated the learning curve experience when developing innovative well programs.

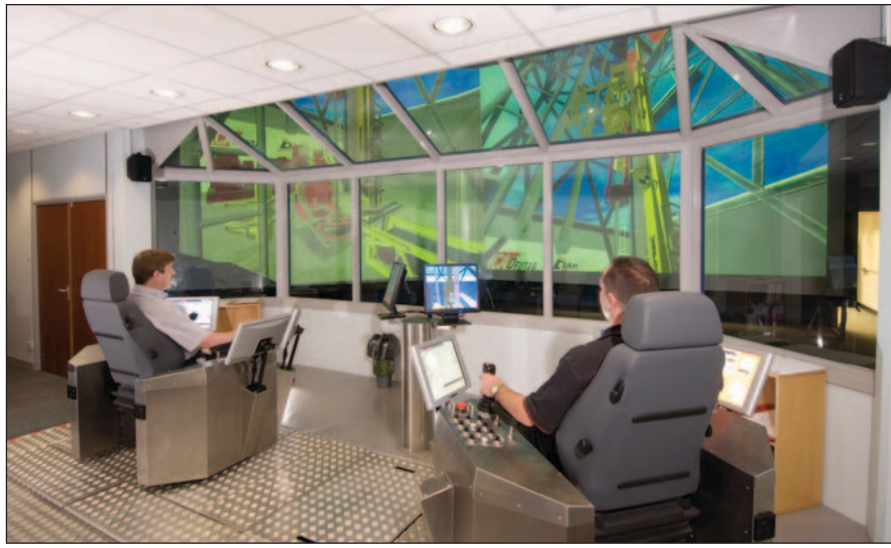
Reducing the Learning Curve Through Use of an Advanced Drilling Simulator (IADC/SPE 98107) RK Hodgson, S Porteous, P Hassard, KCA DEUTAG Drilling Ltd.

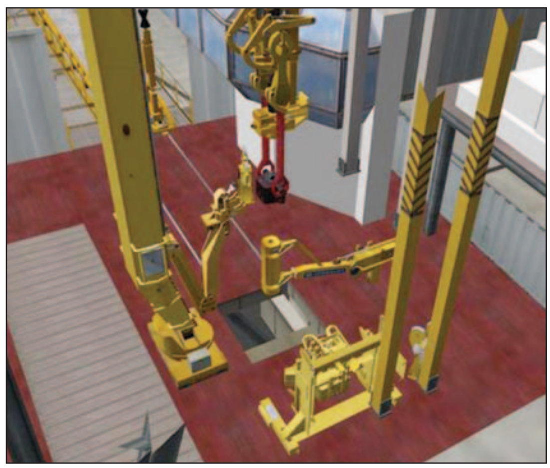
NORWEGIAN TROLL FIELD

In 2001, an innovative service was introduced to the Troll Field Reservoir in the Norwegian North Sea, being founded on a new multisensor data acquisition and processing Measurement While Drilling (MWD) tool. The downhole tool contains various dynamics and mechanical sensors and a high-speed data processing system to continuously provide an accurate picture of downhole conditions and the energy transfer train. This real-time service, as well as the intrinsic detailed studies on BHA and bit design with ensuing in-depth knowledge capture, have lead to a comprehensive understanding of the Troll drilling challenges and thereby facilitated the design and utilization of application-specific bottom-hole assemblies.

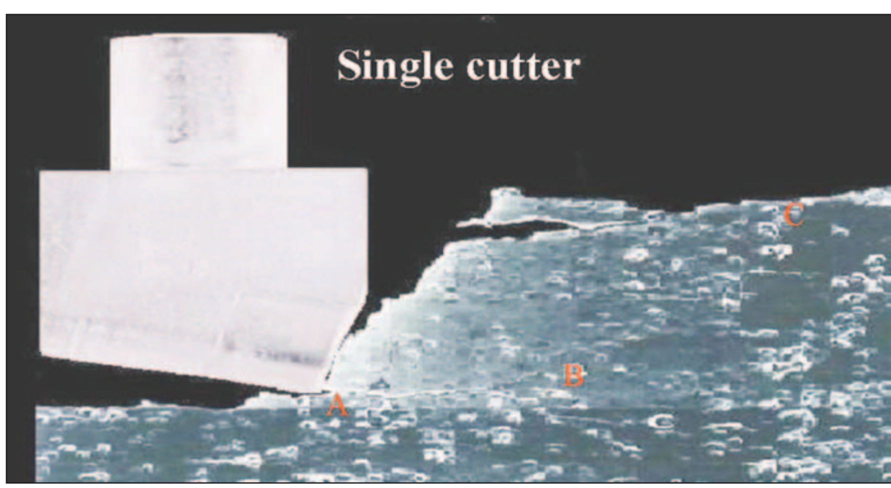
This paper will discuss how this technology is used and how this total drilling system deployment concept was applied to successfully surmount the specific challenges of the Troll Field.

Mitigating Application Specific Challenges Through a Total System Approach (IADC/SPE 99122) M Stavland, Baker Hughes; H Wolter, Hydro Oil & Energy; JG Evans, Baker Hughes.





98107: Drilling simulators — traditionally used for well-control training or the training of crews to operate new-generation automated drilling equipment — are now being used to practice techniques in a low-cost environment with those tasked with onsite execution. State-of-the-art simulators can be programmed to realistically model the proposed operation, with emphasis on well challenges.



98988: Electronic microscope view of chip formation used to develop a new cutter-rock model.

DRILLING THE BUNTER

The Middle and Upper Bunter formation (Triassic) in Northwest Germany is a very hard and abrasive formation, typically in a depth range of 8000 ft to 12,500 ft. It consists of layers of quartzitic sandstone and silificated claystone. Low ROP and high abrasive wear of tools is characteristic for drilling this formation. To improve the performance and decrease cost/ft, intensive research was done in the past.

This paper deals with the results of the analysis of historical data and the development of bits, motors and other BHA components to a total system. This BHA system is to enhance ROP and reduce trips due to dull bits or BHA and drillstring failure.

To date, 15 runs of these improved BHA systems have been performed. Performance data have been analyzed and will be presented to document achieved improvements.

ROP Enhancement In Ultrahard Rock (IADC/ SPE 99045) M Roehrlich, K Belohlavek, ExxonMobil.

CUTTING ROCK INTERACTION

PDC drill bit design is generally done by balancing the bit, distributing uniform wear along the profile and achieving high drillability and control steerability. Drill bit designers adjust features such as profile shape, gage and mainly cutters characteristics.

Cutter rock interaction model becomes a critical feature in the design process. But previous models considered only three forces on the PDC: drag force, normal force and side force. Such models are no longer valid with the introduction of PDC cutters with chamfer and special shape.

This paper presents a new cutter rock interaction model with several improvements.

First, it is based on the presence of a build-up edge of crushed materials on the cutting face often described in the literature but never modeled. Secondly, the chamfer, which significantly affects bit ROP, is completely modeled with its shape and size influence. Third, forces applied on the back of the cutter and due to the rock deformation and back flow crushed materials are taken into account. Finally, numerous single cutter tests are shown to validate the new cutter rock interaction model and investigate the influence of the PDC characteristics. The model has been applied to optimize the cutting efficiency and bit steerability.

PDC Bits: All Comes From the Cutting Rock Interaction (IADC/SPE 98988) L Gerbaud, S Menand, H Sellami, Paris School of Mines. ■