

# Bit technology, design solve drilling challenges

## MITIGATING VIBRATIONS

**DESPITE EXTENSIVE RESEARCH** by the drilling community, vibration-related BHA failures are still common today. A reason for persistent failures is that downhole vibrations created by bi-center bits are complex and varied in nature. Episodes of destructive vibrations are, by practical convention, still categorized as “vibration” problems. The industry has a general lack of understanding of how specific types of vibration are related to specific BHA configurations. This lack of understanding has hampered the effectiveness of troubleshooting procedures employed at the onset of vibration problems.

Due to asymmetrical geometries and force-balance issues, bi-center bits are prone to create highly imbalanced forces and severe lateral vibrations. Conventional vibration sensors that are currently available have had some success at characterizing bit-caused vibrations and providing insight into the destructive mechanisms. However, there has been no definitive correlation between conventional vibration sensor data and specific BHA configurations.

The guidelines have been run and proven on several wells in the Gulf of Mexico, resulting in significant improvement in drilling efficiency.

The authors will explain the background to the problem, historical data analysis, pre-drilling objectives, vibration “fingerprinting,” and field results. Two recent case studies from the Gulf of Mexico will be discussed, including the economic impact to Kerr-McGee.

*Mitigating Vibrations in Bi-Centered Drilling Programs* (IADC/SPE 87097) Nancy Seiler, Kerr-McGee Oil & Gas Corporation; Scott George Lapierre, David C-K Chen, Sperry Sun.

## BIT DESIGN TECHNOLOGY

Successful drilling of conventional roller cone applications with new thermally stable polycrystalline diamond cutters and stable bit designs has revolutionized hard rock drilling in several areas of East Texas. The authors will focus on how teamwork, selective testing programs and product improvements com-

bine to create step-change improvements in hard rock drilling.

Bit design enhancements permitted operators to break through the technical limits set by hard formation drilling with roller cone bits. These include stable bit designs and advancements in thermostable cutter technology, both of which will be discussed by the author.



**Bit design enhancements that permit operators to break through the technical limitations set by hard formation drilling with roller cone bits include stable bit designs and advancements in thermostable cutter technology.** IADC/SPE 87098

Knowledge gained regarding operating parameters, including lower vibration running technique (specifically an RPM increase) was the single most important improvement. Contrary to conventional wisdom, it was learned that applying higher rotary parameters (raising the average RPM from 60 to 90) resulted in a significant improvement in penetration rate and footage drilled. Secondary parameter changes involving weight on bit and torque control are also discussed.

*Enhancements in Design Technology and Performance of Stable PDC Bits Revolutionize Hard Rock Drilling in East Texas Fields; Addendum to SPE Paper No. 79797* (IADC/SPE 87098) Fred William McDougal, Anadarko; R

T Fabian, Schlumberger; S C Johnson, ReedHycalog.

## ROCK PROPERTIES

Several computer based methods exist to determine from wireline logs indices that represent a rock's drilling properties, and to use those indices to make automatic drill bit recommendations. These methods commonly represent values of rock property indices at individual depth stations through a well bore. This approach is adequate if the bit selection is for a section of the well where the formations and rock properties are homogeneous. However, bit selection is more difficult if the interval to be drilled contains formations that possess a wide variation in drilling properties.

The authors will demonstrate how the calculation of properties for an interval of the wellbore as a whole can support reasoned selection of drill bit features for that application by a rule-based expert system. The author will also illustrate how the use of measures that represent the rock's drilling properties over the entire bit run leads to significantly better bit design recommendations than can be made using only instantaneous foot-by-foot representations of drilling properties

*New Method of Representing Rock Properties Over Entire Bit Run Improves Computer Generated Bit Recommendations* (IADC/SPE 87100) David Alexander Curry, P B Perry, Baker Hughes OASIS; M Mueller, Hughes Christensen.

## IMPROVED DRILLING

Maersk Oil typically drills the chalk reservoirs in the Danish Sector in 8 1/2-in. sections, with horizontal lengths between 7,000 and 15,000+ ft. The two lithological components of the formation show a large variation in geomechanical properties: a soft, plastic chalk matrix and a hard, brittle chert. Impact loading on cutting structures and penetration difficulties in hard, micro-crystalline chert are generally the limiting factors on longevity and performance. These long horizontal sections highlighted the opportunity for optimizing the durability of single bit runs.

A systematic development was initiated in June 2000 that involved an innovative approach to bit design.

This new design process methodology incorporates two main components. Lab based rock mechanics analysis demonstrates the interaction of bit cutting elements with rock samples from relevant formations, shown by the cutting action of inserts in various geometric arrangements and trajectories. With simulation software, lab data is assimilated to provide a precise simulation of a specific bit design's drilling dynamics. The system then allows iterative modification of the bit design to enhance specific attributes without actually having to manufacture the bit. History matching of field data is also performed to further improve accuracy of the simulation.

The authors will highlight the benefits of a customer-supplier team driven approach to product development that showed clear and tangible economic

*Rock Mechanics Lab Testing and*

*Computerized Simulation of Bit Dynamics Improves Drilling Performance in Horizontal Chalk Reservoirs* (IADC/SPE 87101) **Stuart Gillick, Maersk Oil & Gas; Robert Hamilton, Arno van der Pouw Kraan, Smith Bits; Amardeep Singh, Smith International Inc.**

## **IMPREGNATED DRILL BITS**

A recent well in southern Oklahoma utilized three new impregnated bits to drill the third Bromide (15,000') through Arbuckle (18,700') section in 40 days. Previous offsetting wells required 18 to 20 roller cone, natural diamond and traditional impregnated bits to drill the same interval in 80 to 131 days. The operator reached total depth 21 days ahead of the AFE and \$2.07 million under budget. Reducing dry hole cost more than 30% has positively impacted development plans for the field.

Improvements in bit technology coupled with better hydraulics have made impregnated bits more versatile. A rev-

olutionary interrupted impregnated cutting structure has allowed the impregnated bit to drill shale intervals that would traditionally end a bit run. Improving the performance in the shales has come without jeopardizing the performance of the impregnated bit in the hard abrasive sandstone formations. Advancements in impregnated materials have also substantially improved the bit life by controlling the diamond matrix wear rate to optimize both durability and rate of penetration. This technology combined with improved hole cleaning has increased average p-rate by keeping the bit on bottom and reducing the number of trips thereby avoiding potential problems associated with tripping through depleted and sensitive formations.

*Application of New Impregnated Technology Saves Operator \$2 million Drilling Southern Oklahoma Well* (IADC/SPE 87096) **C West, Marathon Oil; B Wiesner, M Isbell, Hughes Christensen.** ■