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# New Bit Designs Optimize Performance

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Sagging global economic conditions have taken a toll on rig counts worldwide, but lower oil and gas prices, less available capital, and fewer wells scheduled to drill make one reality all the more imperative for operators: the need to rely on innovation and technology to optimize drilling results and hold well costs in check.

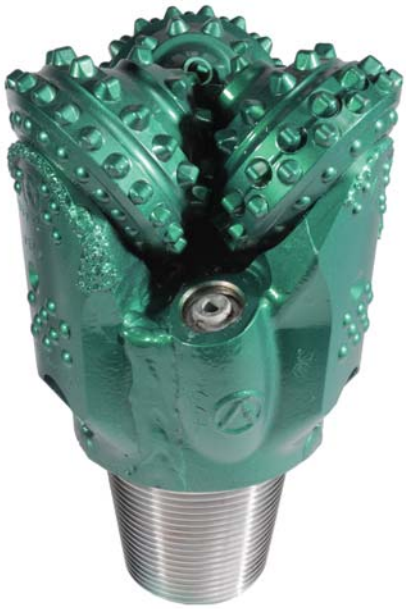
With oil and gas companies high-grading their prospect inventories to cull the most attractive drilling targets, and demanding new plays emerging both on land and offshore–from cutting 4,000-foot horizontal laterals through ultralow-permeability gas shales, to grinding through 30,000-plus feet of salt and sediment in the ultradeepwater Gulf of Mexico Lower Tertiary trend–both efficiency and innovation are a premium. Not surprisingly, operators are turning to one of the most fundamental, yet critical links in the drill string to overcome tough drilling challenges while also getting wells to total depth as quickly and cost-effectively as possible: the drill bit.

Bit manufacturers are responding with high-performance expandable reamers, PDC bits with improved steerability and directional control, fixed-cutter bits with controlled torque response, long-life roller cone bits designed for fast penetration rates, as well as new cutting structures, engineering modeling, hydraulics packages and other design enhancements.

### Roller Cone, PDC Bits

Varel International is offering new roller cone and PDC bits that encompass technological innovations across the spectrum of drill bit design, manufacturing and application, according to Cary Maurstad, Varel product manager.

As operators drill faster and in more challenging lithologies, drill bit designs must meet the demands of increased energy requirements, such as greater weight-on-bit and higher rpms, he explains. To meet these challenges, Varel has developed the High Energy™ roller-cone series that can reliably withstand high energy inputs while maintaining drillers' expectations of high ROP and increased footage, Maurstad states.



**Varel International's High Energy™ roller-cone bits are engineered to reliably withstand high energy inputs while achieving high penetration rates and increased footage. The new bits feature an improved seal and bearing system along with V-Jet™ enhanced hydraulics. In a series of runs in Tarrant County, Tx., the new bits drilled 29 percent faster compared to the closest offset.**

The new bits include two patent pending developments: an improved seal and bearing system along with precision hydraulics. "We took a 'total systems' approach when developing the High Energy series, examining the effects of each modification on other bit components," Maurstad relates. "We looked at each piece of the puzzle and designed innovative solutions for each piece. The High Energy series is not simply a new design; it is an incorporation of technology that resulted in a new design platform."

A patent pending conical seal gland is the cornerstone of the series and positions the seal in such a way that it maintains a preferred sealing location and interface, Maurstad explains. The addition of a patent pending heat shield disc deployed between the seal and the bearing end acts as a thermal insulator, protecting the seal from excessive thermal energy, he elaborates.

By reducing bearing clearance variations and restructuring the bearing areas, designers were able to incorporate a more robust journal bearing capable of supporting heavier loads, Maurstad says. "An additional modification, an advanced lubrication compensation system, features a self-draining reservoir chamber to reduce cuttings buildup in the bottom of the reservoir, protecting components from damaging debris," he notes.

The V-Jet™ enhanced hydraulics package is included in bits up to IADC 537 to provide improved hydraulic and cleaning efficiencies, Maurstad goes on. Nozzle flow is precisely directed to achieve excellent cuttings cleaning while avoiding erosion of the bit's cones and the bore hole wall caused by recirculation. "Improved hydraulics translates into higher

rates of penetration, more efficient drilling and extended bit life," he states.

In a series of runs for an operator in Tarrant County, Tx., High Energy bits drilled at an average rate of 34.5 feet/hour, which Maurstad says is a 29-percent increase compared to the closest offset, with the bit averaging 681.8 feet per run compared to the closest offset at 623.8 feet.

"This performance level resulted in significant savings to the operator," he holds. "The performance has been paralleled in multiple instances and the bits have shown consistent performance improvements."

**Steerable PDC Bits**

For steerable applications, Varel has re-engineered its entire Navigator™ line of PDC bits, Maurstad reports, to optimize the bits' performance in directional drilling operations with complex well paths, tighter targets and longer extended reaches.

According to Maurstad, the platform of the re-engineered bits is based on a closed-loop system that bridges the company's two proprietary software programs, GeoScience™ and SPOT™. This bridgeable technology allows designers to model a bit's gage and cutting structure, optimize the components based on a given directional drive system, and predict which cutting structure configuration will lead to the desired outcome, he details.

"Now we have a better understanding of the downhole dynamics before we even recommend a Navigator bit to an operator," he says. "We know what kind of environment we are going to have to perform in, and the software allows us to model the bit and provides an opportunity for optimization before we recommend it or manufacture a bit."

Varel employs GeoScience, a proprietary well log lithology and rock property analysis software system, to analyze customer-supplied mud logs, drilling logs and electric log data to build a virtual lithology model of the well bore to be drilled, Maurstad explains. He adds that the methodology allows for more accurate definition of the cutting structure and type of PDC cutter required for the application through SPOT simulated output.

"Using the GeoScience output as a guide, the drill bit design and custom cutting structure is created with the SPOT, an engineering software package that predicts a PDC bit's directional behavior and cutting structure efficiency," Maurstad remarks. "The information then is used to match a drill bit with the operator's needs in term of directional signature as well as provide a performance prediction for the lifespan of the bit."

Additionally, Navigator bits undergo extensive computational flow dynamics analysis for optimal hydraulics, which Maurstad says is especially important in directional applications where steering response can be negatively influenced by poor bore hole quality caused by hydraulic enlargement.

"The combination of application-specific, high-performance PDC cutters, the bridgeable software platform, and advanced hydraulics produces a steerable bit with increased stability, greater trajectory control and improved bore hole quality," he summarizes.

In one Barnett Shale application where stability was a major issue, a 7⅞-inch VM619H Navigator PDC bit successfully drilled 4,531 feet to reach a 9,885 feet TD in 45.25 hours at 100.13 feet/hour. The higher-than-expected ROP saved a full day of rig time, Maurstad concludes. ❐