Novel, Refined Bit Designs

By employing advanced modeling and simulation technologies alongside an ever-deeper understanding of specific applications, bit designers are discovering ways to push their creations farther and faster than ever before.

Offer Speed And Durability In Demanding Applications

By Colter Cookson

The development of drill bit technology moves at a rapid pace, responding to the evolving needs of an industry focused on drilling deeper targets and longer laterals more efficiently and safely than ever. Every time oil and gas companies encounter a new operational challenge or seek to take drilling performance to a new level, bit designers hit the drawing board to engineer next-generation solutions for a diverse range of applications, from drilling 30,000-foot subsalt wells in the deepwater Gulf of Mexico to drilling out multistage fracture plugs in extended-reach horizontals in the hills of Appalachia.

Whatever the target reservoir, the success of any bit design can be measured in three words: steerability, durability and speed. By leveraging advances in modeling and simulation technology, designers are delivering these hallmarks of efficiency in some of the industry's most challenging applications.

In many cases, the effort to maximize efficiency involves pushing the performance of hybrid bits to new heights. Refined hybrids are setting benchmarks in demanding carbonate formations such as those in the Permian Basin, and in complex geologies such as those in California. Meanwhile, PDC bits are using novel cutting structures and tough materials to improve drilling speeds and distances across the United States.

According to Cary Maurstad, Varel International's global product manager for roller cone and fixed cutter bits, the SlipStream RC Pro® marries tungsten carbide insert roller cone and steel tooth roller cone technology in a hybrid design to significantly increase frac plug drill-out speed and the number of plugs drilled per run. To illustrate, he cites an Eagle Ford study that compared 25 wells drilled with first- and second-generation SlipStream RC Pro bits to 32 wells drilled with standard-steel-tooth roller cone bits. "The hybrid bits were 13.6 percent faster than standard-tooth bits and averaged 3.3 more plugs per use," he reports.

The SlipStream RC Pro® frac plug drill-out bit from Varel International features a high-capacity grease reservoir to extend the bit's life, enabling it to drill more plugs on each run.

The bits work so well because they are designed for the unique challenges associated with the coiled tubing drill-out process, says Karl Rose, Varel's Western Hemisphere operations engineering manager. He points out that this process exposes the bits to high rotational speeds and temperatures as hot as 350 degrees Fahrenheit.

"In addition, the drill-out process washes out and recovers small-grain frac sand at wellhead pressures between 4,000 and 5,000 psi," Rose continues. "Pressure spikes encountered drilling into each isolated zone can cause rapid cone pumping and grease loss that reduces bearing life. At the same time, hydrocarbons can cause seals to become hard and ineffective."

The plugs themselves can present an issue, Rose adds, noting that most have a hard outer portion and a soft middle. The outer portion quickly degrades cutters, while the middle generates large cuttings that are hard to circulate, he explains.

"To effectively drill the two very different plug materials, the SlipStream RC Pro has both steel tooth and TCI cutting structures on each cone," Maurstad reports. "We also developed a new bearing and compensation system that provides greater resistance to pressure spikes and chemicals."

The TCI cutting structure is on the outside of the cones to drill the hard part of the plug, Maurstad details, noting the inserts are subjected to a patented high-energy tumble process to increase durability. Short and closely spaced steel-tooth inner rows provide small cuttings for easy transport, Rose adds. He estimates the cuttings typically are smaller than half the size of conventional-tooth-bit cuttings, significantly reducing wash-down time between plugs.

To mitigate pressure spikes and ensure adequate grease, the bit's lubrication system employs a patented attenuator and has a grease reservoir with 250 percent more capacity than previous designs, Maurstad continues. The fully contained grease diaphragm offers greater durability under rapid cone pumping. Seals are manufactured from a highly saturated nitrile material with more thermal stability, broader chemical resistance, and greater tensile strength than regular nitrate compounds, he reports.

These durability enhancements have paid off, Rose assures. As an example, he offers an application in Atascosa County, Tx., in which the bit drilled one bridge plug and 25 frac plugs in 234 minutes for an average drilling time of nine minutes per plug. The bit experienced minimal wear with a dull grade of 1-2-WT-G-EEE-X-ER-TD.

"More than 254 drill-out runs have been completed using the bits. The latest generations have almost doubled the number of plugs drilled out during each run while remaining in excellent shape," Rose concludes.