Originally appeared in World Oil® APRIL 2018 issue, pgs 61-63. Posted with permission.

Collaboration leads to successful application of new drill bit design

As producers and service companies emerge from the downturn, it has become evident that cooperation is required to optimize drilling operations, increase ROP and reduce overall costs.

CHRIS CASAD, Ulterra

An example of a cooperative relationship was demonstrated when Ulterra, a producer of PDC drill bits, and a large independent E&P company—operating in the Eagle Ford shale—combined forces to examine ways to improve performance. Ulterra was developing a new PDC bit design and looking for challenging applications. At the same time, the operating company was focused on ways to improve drilling performance in its Eagle Ford properties.

One of the primary concerns associated with E&P companies' drilling efforts has consistently been related to low rate of penetration (ROP) and excessive time to reach total depth (TD), along with rig safety. While ROP is a primary contributor to increasing overall time to reach TD, safety is also a major concern. The number of times that an operator must trip in and out to change bits is a key factor, making bit durability and versatility another key factor for both safety and efficient use of rig time.

PERFORMANCE LIMITERS

These key concerns—ROP, bit durability, versatility and safety—were all considered as the operating company planned its horizontal shale operations in Karnes, Atascosa, McMullen and Live Oak counties in South Texas. These same considerations were addressed in meetings between Ulterra's application engineers and the company's Eagle Ford drilling personnel.

It's a long-held belief within industry circles that poor cuttings evacuation can be a major cause of limited ROP. When a drill bit's hydraulics do not effectively evacuate cuttings, they remain trapped on the tool face, and drilling performance is significantly degraded. When this occurs, cuttings will continue to recirculate around the bit, collecting locally around the cutters and junk slot. A great deal of energy that could be used for drilling is expended on constantly recirculating these cuttings. In addition, when cuttings are trapped on the tool face, steerability is reduced significantly, and the bit can be damaged as a result of rising temperatures. Poor cuttings evacuation is a major performance limiter during drilling operations.

DEVELOPING A SOLUTION

Ulterra recognized the opportunity for a more dramatic, step-change innovation which would address the key issue of poor cuttings evacuation. While there was a good awareness in the industry that cutting evacuations are a significant performance limiter, the issue had not been resolved effectively by incremental developments in drill bit design.

Fig. 1. The SplitBlade bit is designed to improve ROP and increase durability, while improving tool face control.

In response to conventional bits' poor evacuation of cuttings, Ulterra ultimately created a solution with a true evolution in PDC bit design. The new bit is called SplitBlade, because it features a unique design in which its rotating blade shoulders and primary blades are separated after the cone, Fig. 1. The bit's inner blade geometry is offset forward to create further separation, providing specific large-volume flow channels that carry away cuttings more easily, freeing up drilling potential, Fig. 2. With SplitBlade, cuttings are cleared out of the core up to seven times faster, compared to conventional PDC designs.

The new bit design also features a two-pronged approach to increasing the maximum hydraulic dispersal rate, providing further improvement in cuttings evacuation. The bit's nozzle positions are uniquely designed to create dedicated fluid channels and ensure that cone and shoulder cutters receive a high volume of fresh hydration, which adds to bit life. In addition, the firm's specially designed, high-velocity, tilted nozzles were built into the new bit to channel a greater volume of drilling fluid on the cutters themselves, Fig. 3. This design breakthrough provided for more advanced bit hydraulics and significantly improved bit face cleaning.

An important advancement in PDC bit engineering, the new design further provides a solution to performance limiters by using superior bit hydraulics to expand the performance threshold. The bit's hydraulic dispersal rate has been redesigned to provide broader channels for the evacuation of cuttings, effectively preventing cuttings recirculation and improving both cutter performance and ROP. In addition, the new bit delivers improved tool face control for effective directional drilling in the curve, while providing outstanding steerability over long laterals.

Fig. 2. CFD software was used to focus the path of cuttings evacuation and optimally channel fluid flow.

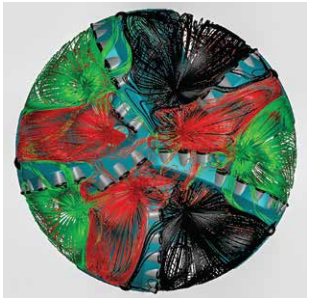

Fig. 3. The new PDC design features separation of the primary blades, creating double-barrel hydraulics that free up more area for the junk slot.

APPLICATION-SPECIFIC DESIGN

The bit's ability to readily change cutter placement became an important aspect of the E&P company's drilling program in the Eagle Ford. The premium-grade PDC cutters feature a layout that provides for greater radial freedom. These cutter layouts are engineered specifically by work and force simulations for optimal drilling performance and can be modified to meet specific application requirements.

Working with the operating company to meet the challenges of drilling in the Eagle Ford, Ulterra revised the bit's design to include an altered diamond depth for improved cutting control, along with better steerability and tracking. This customized PDC bit would be able to complete straight-hole drilling operations at high ROP, as well as drill the curve and long laterals with the same bit. The long life and versatility also would reduce the number of trip-ins and trip-outs, decreasing required rig time and significantly cutting drilling costs.

PERFORMANCE RESULTS

The operating company engaged in approximately 40 pad drilling operations, using an 8¾-in. SplitBlade bit (UDT 7142) over a span of three months. The average footage drilled in these wells was estimated at 18,500 ft, with the average true vertical depth at approximately 11,500 ft. The average lateral section was 12,500 ft. The time-savings associated with drilling these wells with the customized bit was approximately 30%, compared to conventional PDC bits. In addition, the bits were used in all sections of the well, including the vertical borehole, the curve and lateral intervals. Data taken from these wells showed significant improvement in tool face control, with sliding in directional segments reduced approximately 20%.

PLAN GOING FORWARD

Ulterra's business model emphasizes collaboration with its operating companies. The symbiotic relationship has improved performance in U.S. shale fields. The E&P companies contribute their first-hand field experience and application requirements that become an integral part of the development of innovative PDC bit designs. Similarly, Ulterra benefits from having access to the E&P companies' wealth of drilling data and experience.

The partnership with the oil company in the Eagle Ford is ongoing, and Ulterra recently implemented a 12¼-in. SplitBlade. On a trial run, the bit drilled each section in 21 hr, compared to 24 hr required by other type bits. The larger bit is expected to perform to the same standards as the original 8¾-in. design. WO

CHRIS CASAD is the innovation production manager in Ulterra's Innovation Engine Group, which he helped establish in 2014. Prior to that, he was Ulterra's engineering manager for automation, innovation and technology. Chris started his career in 2003 as a design engineer, after graduating from the Rensselaer Polytechnic Institute, with degrees in mechanical engineering, and product design and innovation.

World Oil article