CLEARING THE CUTTINGS CONUNDRUM

Chris Casad, Ulterra Drilling Technologies L.P., USA, discusses how new drill bit designs enhance cuttings evacuation and improve efficiency.

The push to address a longstanding problem has led to a new development in drill bit design.

The problem relates to the commonly held belief that the poor evacuation of cuttings from drilling operations can significantly limit bit performance, and ultimately the rate of penetration (ROP) – a major concern in drilling operations. This issue is due to the design of traditional drill bits, which do not provide an efficient means of evacuating cuttings, leaving them trapped on the tool face. When this happens, the cuttings continually recirculate around the drill bit cone, collecting around the cutters and junk slots. Energy that should be used for drilling is, instead, expended on recirculating these cuttings. In addition, when cuttings are not efficiently removed from the cutting face, tool face control and steerability is compromised, and the bit can be damaged as result of rising temperatures.

For all of these reasons, poor cuttings evacuation can be a major performance limiter in drill bit design.

An opportunity

While there has long been an awareness of the issue of cuttings evacuation as a serious limiter to drilling performance, the problem had never been effectively resolved by drill bit designers. Ulterra recognised the opportunity for a blade design that would address the critical issue of poor cuttings evacuation, and worked to develop a solution.

The development work resulted in the invention of a new bit, the SplitBlade™. This name was based on the bit's design, which features a split geometry in which the inner blade geometry is offset forward. One factor is the bit's rotated shoulder design. The primary blades separate past the cone to free more area for the junk slot and prevent cuttings recirculation. This design creates specific large-volume flow channels that are capable of more readily carrying cuttings away from the face of the bit. Cuttings are therefore cleared from the cone up to seven times faster compared to conventional PDC designs, freeing up the bit's significant drilling potential.

Additional benefits

The SplitBlade design provides further improvement in cuttings evacuation through a significant increase in the maximum hydraulic dispersal rate, creating a 'double-barrel' hydraulics effect. The bit's nozzles are positioned to create dedicated fluid channels, ensuring that a high volume of fresh hydration reaches the cone and shoulder cutters, adding to bit performance and longevity. The high-velocity, tilted nozzles are built into the bit, in order to channel more drilling fluid onto the cutters themselves. In addition, this advanced bit design breakthrough provides for significantly improved bit face cleaning, adding to its overall enhanced performance.

The bit's hydraulics are also designed to deliver additional benefits that expand the performance threshold. The increased hydraulic dispersal rate provides broader channels for the evacuation of cuttings, which prevents the cuttings from being recirculated, improving cutter performance and ROP. In addition, the bit's improved tool face control offers more effective directional drilling in curves, with good tool steerability over long laterals.

As a result of the versatility and durability of the new bit design, the number of trips in and out to change bits can be reduced. The blade performs well in straighthole and lateral drills and has produced impressive dull grade scores after multiple runs. With less tripping, rig safety is improved, and expensive rig time is saved.

One feature of SplitBlade is the ability to readily change the bit's cutter placement. The PDC cutters also feature a layout that provides for greater radial freedom. These cutter layouts are engineered for optimal drilling performance, and can also be readily modified to meet specific application requirements.

Working with an operating company in the Eagle Ford shale of South Texas, Ulterra provided a custom SplitBlade, featuring an altered diamond depth to achieve improved cutting control, steerability, and tracking. This modified design resulted in high ROP performance, and was able to complete drilling of straight-hole, curve, and long laterals with the same bit. The durability and versatility also reduced the number of trip-in and trip-outs, reducing rig time and drilling costs.

The proof is in the drilling

Initial field runs of the SplitBlade technology were performed in the Eagle Ford. Ulterra engineers worked closely with several operators to modify and improve the unique blade and nozzle design.

One particular case study occurred in Lavaca County, where an SPL616 drilled the entire curve and lateral in 67.8 hrs. Total footage drilled was 11 652 ft compared to an offset of 8584 ft. ROP was 172 ft/hr, compared to the next fastest offset of 143 ft/hr.

These types of early performance milestones encouraged operators in other areas to adopt SplitBlade, resulting in recent record runs in the Permian Basin of West Texas and New Mexico, the Anadarko Basin of Oklahoma, and elsewhere.

Three cases, which are being reported for the first time in this article, have demonstrated the effectiveness of the bit's design.

Figure 1. *SplitBlade is a new development in PDC drill bit engineering, with a design that improves cuttings evacuation, ROP and tool face control.*

Figure 2. *SplitBlade features separation of the primary blades, creating double barrel hydraulics that free up more area for the junk slot.*

Case 1: Andrews County, Texas

In Andrews County, Texas an operator used an 8.5 in. SPL616 SplitBlade bit with a rotary steerable system (RSS) in the lateral section. The bit not only maintained a solid ROP, but set a record for most lateral footage drilled with one bit. The bit completed more than 10 000 ft in this section to a total depth beyond 21 000 ft. In fact, the bit holds 8 of the 10 longest lateral runs for this operator in the Permian basin over a 19 month period and continues to show improved performance in terms of footage drilled and penetration rates.

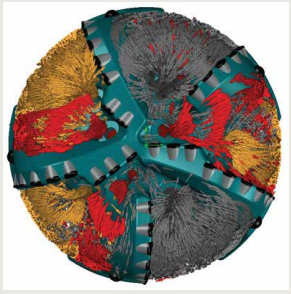

Figure 3. *In the design of SplitBlade, computational fluid dynamics (CFD) software was used to focus the path of cuttings evacuation and fluid flow for better performance.*

Case 2: Northwestern Alberta, Canada

A 12.25 in. SPL625 bit was used in northwestern Alberta, Canada to batch drill five surface holes. The bit, equipped with the SplitBlade technology, drilled more than 3000 m in less than 45 hrs for an ROP of 67.5 m/hr. Also important was the fact that the bit was pulled out of the last hole with a 0-0-NO-TD dull grade after five runs. The performance significantly enhanced the economics of batch drilling on multi-well pads, saving the operator considerable rig time and money.

Case 3: Central Oklahoma

In the STACK play (Sooner Trend Anadarko Canadian Kingfisher) of central Oklahoma, an 8.5 in. SPL616 SplitBlade was used to drill the lateral section. At upwards of 150 ft/hr, the blade not only set numerous records for ROP in this lateral, it also set this operator's 24 hr footage record of more than 4300 ft. According to daily run records, the bit actually drilled faster deeper into the run. This was another rotary steerable application where the SplitBlade combined speed and durability for enhanced performance.

Conclusion

By addressing the problem of poor cuttings evacuation, the designers of SplitBlade have created a bit that is setting new performance benchmarks in a wide range of environments and applications. As a result of its improved cuttings evacuation and improved hydraulics, the design helps deliver enhanced levels of performance, versatility, and durability.

By working in close collaboration with key operating company customers, the designers have been able to gain first-hand insight into the many application requirements and operational challenges faced by E&P companies, and introduce important productive innovations in PDC bit design.