DON'T LET IT SLIP

Kelly Berndt, Drilformance, USA, presents a new drilling technology that aims to eliminate slide and improve overall ROP.

Everyone has heard the old adage that the shortest distance between two points is a straight line. This has never been as true as in today's drilling programmes racing to the end of a long lateral section. In these environments, high rotating rate of penetration (ROP) can be erased by excessive slow sliding ROP. In order to improve the overall run, the sliding time must be focused on and reduced. There can be some cutting structure adjustment to improve sliding ROP, but at the end of the lateral transfer of weight to the bit can be a problem and when there is a weight transfer issue, slide ROP will suffer.

The Drilformance team has engineered an alternative solution to just improving slide ROP. The company aims to eliminate slides whenever possible. Through precise adjustments to the cutting structure, the DrilStraight feature

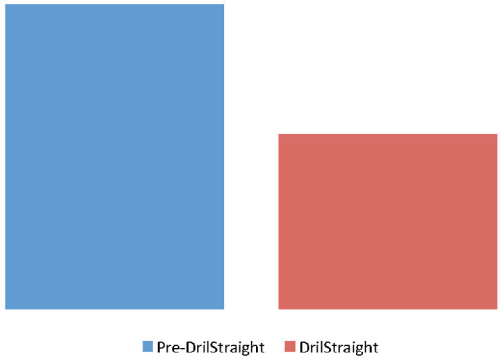

Figure 1. *Average lateral force by cutter.*

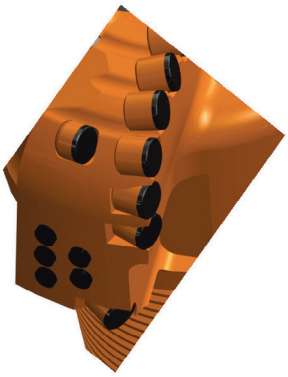

Figure 2. *Gauge view of DrilStraight cutting structure.*

Figure 3. *Face view of DrilStraight cutting structure.*

Figure 4. *View of HeliPath feature.*

was developed. DrilStraight technology works to mitigate the lateral aggressiveness of the bit and dramatically increases the tracking ability of the bottom hole assembly (BHA), with little-to-no impact on build rates. DrilStraight allows the BHA to stay on track and lessens the need for corrective slides. Fewer corrective slides translates to rotating a higher percentage of the lateral and improving operator's overall ROP.

Conceptual development

The DrilStraight technology was developed from the concept that a cutting structure can influence the tracking ability of a BHA. If the cutting structure is more perpendicular to the drilling axis, the cutters themselves will be in line with the weight on bit and will drill more efficiently. Alternatively, if the cutters are not perpendicular, each individual cutter has some lateral bias, even though the entire cutting structure is force balanced. If one row of cutters instantaneously does more work than another row, the cutting structure will cause the BHA to deviate from the intended drill path. The DrilStraight cutting structure was designed to reduce individual lateral force. An initial design did so by 74.7% on a per cutter basis for the given operating parameters from the previous design.

Many bit companies have attempted to make a bit track in the past. Designs with longer gauge pads, deeper cone angles and parabolic shoulder layouts have all been tried with limited success. These design ideologies all have their drawbacks and were first conceptualised in vertical drilling, sometimes with straight-hole mud motors. As one can imagine, concepts for vertical drilling are not always ideal for horizontal drilling. Longer gauge pads increase the bit to bend length and lower the theoretical build rates, which increases slide distances required when making corrections. A deep cone angle bit lowers the efficiency of the design and leads to a fragile nose of the bit, both of which are detrimental to increasing distance drilled and rate of penetration. Parabolic shoulder layouts are very limited in their ability to build angle and are also a less efficient cutting structure, causing both longer corrective slides and slower rates of penetration.

Because the core concept of the design was to increase efficiency, DrilStraight technology is able to avoid these drawbacks. The technology is novel in its ability to build angle while sliding. Incorporating the gauge management aspect of the system allows the cutting structure to efficiently cut the rock both in slide and rotate modes. Because the bit only drills the direction the bit is biased, build rates in slide mode and tracking in rotate mode can both be achieved. The ability to build angle and track is necessary as more wells are using the same bit to drill the curve and the lateral sections.

The new design does not stop at the gauge management system. The face cutter layout is equally important. By creating a profile that allows many point loads as well as a smooth cutter engagement, the cutting structure never overbites with any individual cutter and therefore resists deviation from the drill path. Axial aggressiveness is maximised by concentrating the drilling elements in a perpendicular direction to the drilling path. The workload of the cutters is smoothed using OptiTrak software technology. Because more point loads are beneficial to DrilStraight designs, the bits also have an added benefit of improving the durability of the design. Toolface control is based on the cutting structure, so the bits are steerable in all torque and rate of penetration arrays. The ability to track is also available at all rates of penetration and all different

rock types. The technology has been designed so that it can be incorporated into any bit design regardless of blade count or cutter size.

The new technology is a design feature that integrates well with Drilformance's existing bit technology. The unibody steel design allows the bit body to have a very short makeup length. This increases the theoretical build rate of the bottom hole assembly (BHA). Cryo Edge cutters allow the bit designs to be run in virtually any drilling environment through their ability to improve both impact and abrasion resistance. Rhino Armored hardfacing eliminates erosion of the bit body. The HeliPath cutting structure concept creates a redundant cutting path in the centre of the bit, helping provide strength while also using the kerfing trough to increase lateral stability. While each of these design features alone has proven, technologically solid results, it is the entire system that achieves enhanced performance. The final product improves steerability, tracking, rate of penetration and durability.

There are also secondary benefits to drilling a straight wellbore. Because there are fewer doglegs in the well, pipe drag will be reduced, due to less friction against the wellbore. This should lower the overall parasitic torque of the system. Allowing more torque to be used to drill provides gains in drilling efficiency. In a smooth wellbore, casing or completion operations should be easier and more reliable. If the bit stays in the target zone of the formation, completion and production operations should benefit.

Finally, the importance of bit face and hole cleaning is difficult to understate. While drilling the lateral, the gravity and path of least resistance conspire to drag cuttings to the low side of the wellbore while the drilling fluid becomes a figurative conveyor belt along the high side of the annulus. Rotation of the drillstring is the most effective method to stir up the cuttings and force them into the conveyor belt. DrilStraight technology helps decrease both the footage drilled and time spent sliding. When operators replace slide footage with rotating footage, they produce a higher quality wellbore.

Case studies

Eagleford

In a recent well comparison in South Texas, DrilStraight bits were run against an earlier design. The system was well optimised, leaving very little time to be saved. In initial tests of the technology, the rotate ROP was only 97% of the previous design, but the hours to TD were identical. This was due to the lower percentage of slide time and a higher slide ROP of the DrilStraight design. Because the directional drillers were sliding less, the variation from one rig to another in terms of performance was reduced.

Lower Shaunavon

In a field in Southern Alberta, Drilformance was asked to improve upon an existing design. By implementing the DrilStraight technology, the bit design was able to drill roughly 50% faster in a high rate of penetration drilling environment. This was accomplished without sacrificing the steerability of the design.

Because the rotational drilling was nearing the technical limit for ROP in the system, a lot of the improvement was based on sliding faster with less frequency. While there were

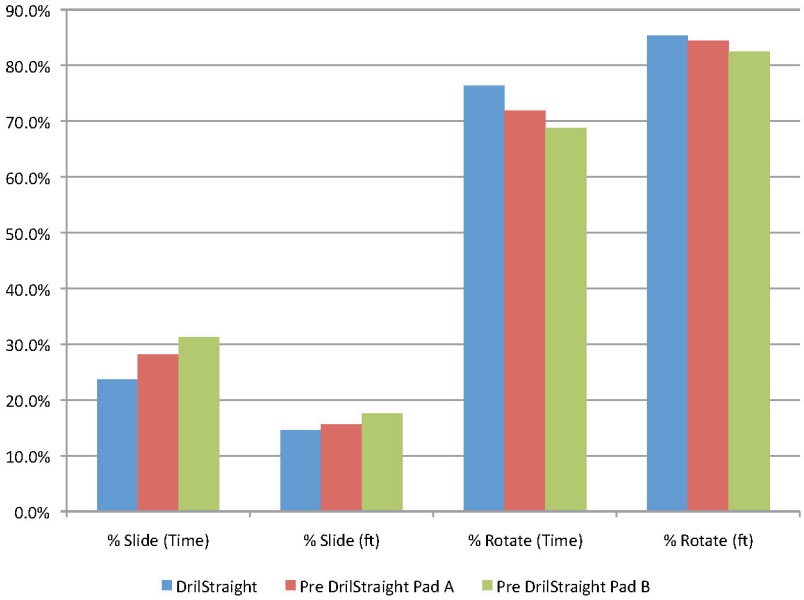

Figure 5. *Breakdown of Slide and Rotate comparison in Eagleford curve and lateral section.*

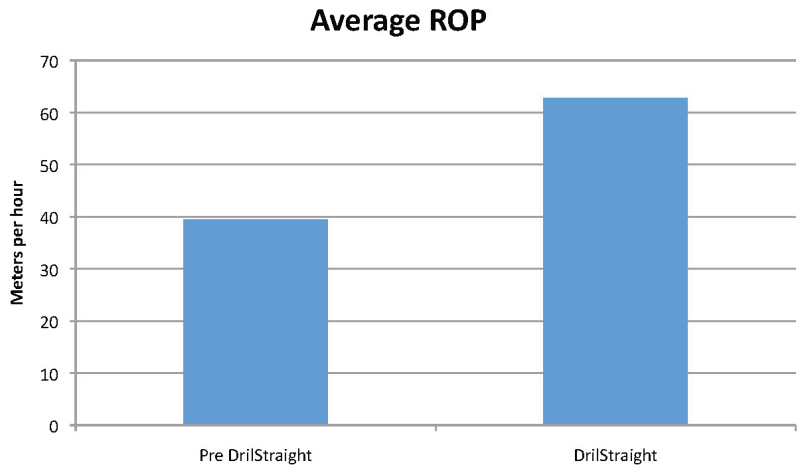

Figure 6. *Average ROP comparison in lower Shaunavon lateral.*

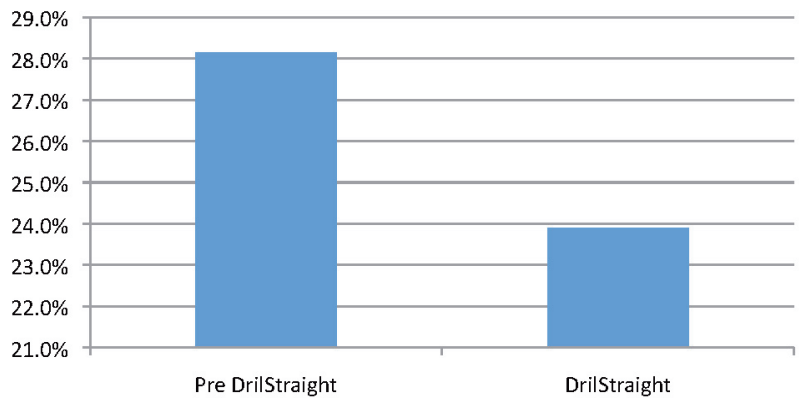

Figure 7. *Percentage of time sliding comparison in lower Shaunavon lateral.*

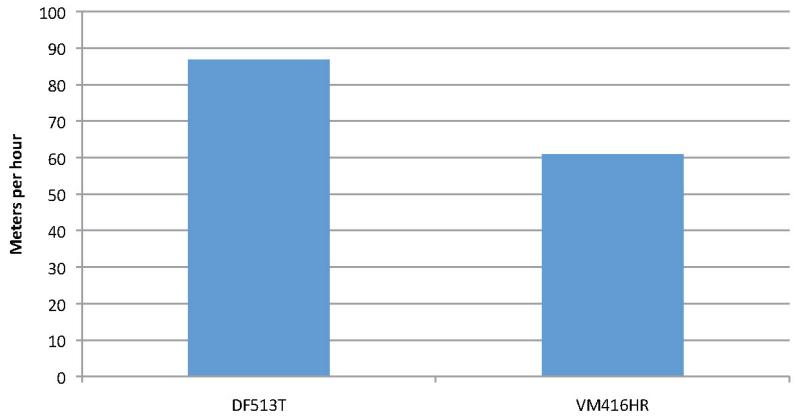

Figure 8. *Average ROP by bit type-Bakken formation.*

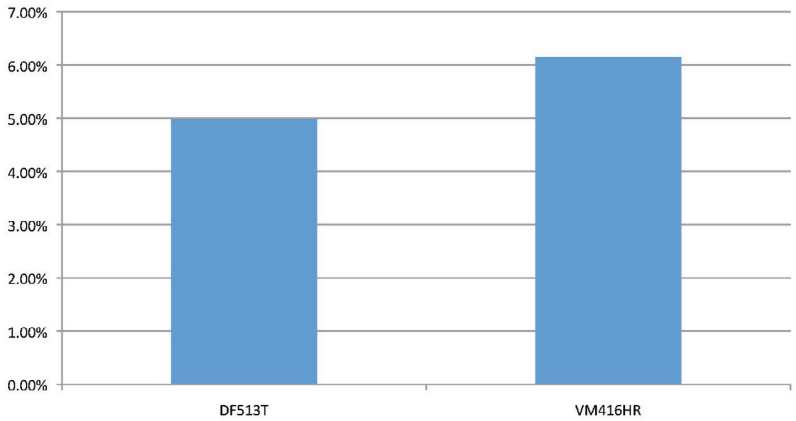

Figure 9. *Slide percentage of total distance drilled-Bakken formation.*

improvements in both areas, the ability of the bit to track and therefore slide less resulted in the biggest performance gain. The new bit spent 17% less time sliding.

Bakken

An operator was looking to improve an already impressive ROP in the Bakken formation in Saskatchewan. By running the DrilStraight cutting structure, the operator was able to improve their average ROP by 43% and slide 23% less distance. The directional driller commented that he was able to rotate more stands of pipe between slides than ever before. Cutting the lateral section in less time means significantly less time is spent on each well and will have a positive impact on overall drilling economics. In shallower total vertical depth (TVD) wells, lowering the hole drag becomes more crucial because the system is limited by how much weight is available from the drill pipe in the vertical section to overcome the drag of the drill pipe in the horizontal section. By lowering the amount of slides because the bit is tracking, the drag in the lateral section can be lessened.

Conclusion

It is safe to say that the fastest slide is the one that never happened because the bit was tracking. By utilising technology such as DrilStraight, operators can expect to rotate more and slide less without sacrificing any desirable drilling benefits. Because the process increases the efficiency of drilling, rate of penetration can increase while steerability remains constant. Secondary benefits such as lower torque and an easier time getting casing to bottom can also be experienced. The technology can be incorporated in many different blade and cutter layouts to be optimised for all drilling environments. New technologies such as this can change the way the industry thinks about horizontal bit design.