Slimhole rotary steerable system now a reality

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OFTEN, AN OPERATOR DRILLS a mature field to find untapped pools of oil. Many times this involves reentering an older well and drilling through the existing casing, an operation generally carried out in 6-in. hole.

The drilling environment requires sliding, which can reduce ROP by at least 50%, increase the risk of differential sticking, and reduce the ability to drill a highly deviated well profile.

To improve performance and reduce risk, an increase in hole size may be necessary. Operators have to cut and pull casing from higher up the well and drill a 12 1/4-in. hole, followed by an 8 1/2-in. hole to finish. Pulling all that casing and then drilling an extra hole is very expensive.

Now there is an alternative: a 4 3/4-in. rotary steerable system that has the advantages of a highly ruggedized, larger rotary steerable system, and is field-proven both onshore and offshore.

Schlumberger now provides a rotary steerable system called the PowerDrive* 475. This new system can accommodate designer wells, providing rotary steerable drilling in 6-in. holes.

The system consists of a control unit containing a valve that remains stationary amidst the rotation around it, and a bias unit with three moveable pads.

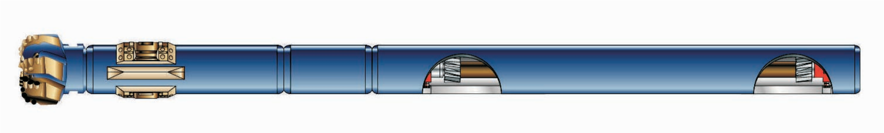
As the bias unit rotates, mud pumped from the surface is directed to each pad in turn as it passes the opposite position to the intended direction of deflection. This is the synchronous biasing mechanism that pushes the bit in the desired direction.

A new optimized valve design provides a valve phase angle that leads to dynamic steering bore optimization. The new design also uses materials and face contours that reduce valve friction.

Also, it employs a new spring-loaded mechanism that significantly improves steering performance under shock and vibration. The resulting increase in strength and wear resistance of the biasing system components can ultimately lead to longer runs and greater reliability in harsh and abrasive formations.

Bias unit design features include pads that use tungsten carbide tiles and TSP inserts for advanced wear properties. New seals for the bias unit pistons ensure a long service life.

Building on experience gained with the previous generation of rotary steerable systems, an improved kicker-plate design uses hard-weld overlays that improve wear life.



The PowerDrive Xtra slimhole rotary steerable system is the result of a major redesign that incorporates a wide range of reliability and performance enhancements, from advanced downhole electronics and tool hardfacing, to real-time communications and an advanced surface control system.

Specially selected metallurgy is incorporated into the one-piece control shaft design, enabling it to withstand high torque and shock conditions.

Hinge pins are fabricated using a material approximately 40% stronger than the previous generation rotary steerable tools, and are better able to withstand conditions of extreme shock and vibration.

The control unit and its pressure housing are designed and certified to withstand high levels of downhole impact and vibration.

All electronics and circuit boards, including sensors and communications circuits, have been designed to rigorous standards of ruggedness.

This was a particularly steep design challenge considering the amount of space available to place electronic components, as well as the harsh pressure and temperature conditions under which the system would have to operate.

One of the innovations was the use of new torquer electronics to assure control in high-temperature applications. In addition, the torquer's temperature range was further extended with the use of specially formulated elastomers.

CASE HISTORIES

In April and June, Schlumberger announced successful field tests of the new slimhole rotary steerable drilling system, the first tests for a tool of this size.

The April test took place in the North Sea Brent Delta field, with Shell Expro as the operator. The system drilled 2,377 ft of 6 1/8-in. wellbore in 43.5 hours, translating into an average rate of penetration of 67 ft per hour.

The designer well required three-dimensional steering made possible by the rotary steerable capabilities of the system, which allowed the hole to intersect multiple target zones. The use of this drilling system shaved 8.42 days off the drilling curve when compared to a similar offset 6 1/8-in. wellbore section.

In June, Schlumberger geosteered a 4,712 ft, 6 1/8-in. lateral section in the Safah field onshore for Occidental Petroleum-Oman using the slimhole rotary steerable system.

With the operator seeking ways to produce more oil from fewer wells, the slimhole system enabled drilling a single well trajectory that intersected multiple targets. In addition, adjustments in direction were made during drilling for optimum reservoir drainage.

Both cases illustrated the slimhole rotary steerable system capability of greater directional drilling control using constant rotation, rather than alternation between rotating and sliding.

This enabled drilling a smooth wellpath compared to the rough paths produced when sliding. In addition, more targets in a longer hole section were intersected while minimizing the risk of stuck pipe.

The slimhole system operates independent of mud weight and depth, thus allowing longer runs and fewer trips.

The slimhole rotary steerable system uses simple mud hydraulics to control the pad direction that push against the side of the hole and direct the bit for high-performance three-dimensional trajectory control.

The combination of the innovative hydraulic valve design, new valve timing enabling great accuracy in trajectory control, and the use of low-friction materials that maximize efficiency of the bias unit provides great engineering advantages.

One of these is reliable directional control in doglegs up to 8 degrees per 100 ft. In addition, it is the only rotary steerable system capable of a kickoff from vertical.

With most directional drilling in 6-in. hole being performed today by sliding the drillstring, the slimhole rotary steerable system offers an alternative to changing the wellpath using mud motors with bent or adjustable subs.

With conventional drilling, there is a strong prospect that targets will be missed in the rough wellpaths the sliding process leaves in its wake, as well as hole cleaning difficulties, whereby cuttings build up around the practically immobile drillstring, from which stuck pipe can arise.

In both cases, not only did the new system help geosteer the hole sections in record time, it also enabled the feasibility of their being successfully and economically drilled in the first place.

As the rotary steerable system continues to be developed and improved, its reliability and mechanical simplicity also increase.

For example, a real-time link provides continuous telemetry to the MWD/LWD tool via an electromagnetic non-contacting link. This channel transmits data for inclination and azimuth 7.9 ft behind the bit, thus enhancing the system's ability to drill demanding well profiles.

In addition, the real-time link provides a surface display that confirms tool commands sent to the system from surface.

This feedback control mechanism is vital when critical wellpaths are being drilled and two-dimensional or three-dimensional control is of the utmost importance.

There is an option also that the real-time link can provide a selection of drilling mechanics information from the accelerometers inside the slimhole rotary steerable tool.

Schlumberger also can match the slimhole rotary steerable tool with a number of its own drill bits, thus ensuring high compatibility and performance among system components.

The resulting bit and bottomhole assembly is an integrated package that is optimized to meet directional drilling demands. ■