

# Rotary steerable drilling: faster, smoother wellbores

**EXXONMOBIL HAS** its rig of the future as well as BP, and it includes a rotary steerable drilling system. Conventional directional drilling utilizes a bent housing motor or bent sub in order to deflect the bit in the desired direction. **Jeff Moss** with **ExxonMobil** estimates that about 98% of directional drilling today is done with some type of bent housing assembly. It's tried and true but there are issues with it, including torque velocity. Conventional directional drilling requires drilling to stop which causes problems with hole cleaning.

Drilling directional wells with a rotary steerable system results in a smoother wellbore. This results from constant rotation and deflecting the drillstring through adjustments downhole.

"I am not here to debate the advantages or disadvantages," Mr Moss told the crowd at IADC's annual meeting. "Our company takes rotary steerable drilling as a given. It is not an issue with us."

"What we are after," he continued, "are faster, cheaper and better wellbores. You can pick two but ultimately we want all three."

"Conventional systems are proven and we use them a lot but we do see the advantages of rotary steerable drilling."

## STEERABLE SYSTEMS

Several service companies offer rotary steerable drilling systems. The "big three" includes **Schlumberger**, **Halliburton (Sperry Sun)** and **Baker Hughes (Inteq)**. Several other tools are in the market, including a system offered by **Gyrodatta**, which purchased the tool from another company.

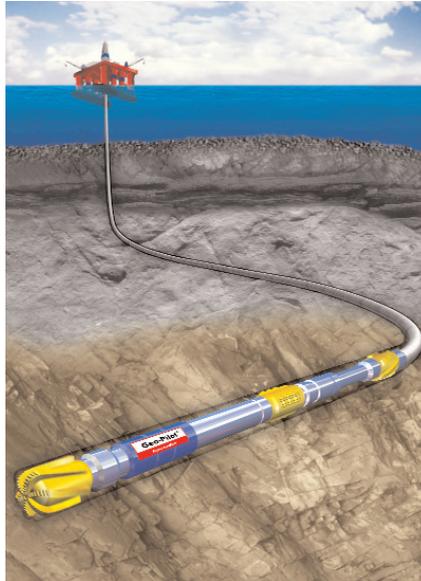
Interestingly, another system was purchased by a company not quite as well known as a member of the drilling service industry as it is as an offshore drilling contractor. **Noble Drilling** recently purchased a rotary steerable drilling system from a company called **WellDone**.

## HALLIBURTON

Halliburton's rotary steerable drilling system, dubbed **Geo-Pilot**, was designed by Sperry Sun in conjunction with **Japan National Oil Corporation**

(JNOC) using point the bit technology.

**Geo-Pilot** utilizes a drive shaft mounted on bearings at each end and enclosed in a non-rotating outer sleeve. The drive shaft is deflected in the middle by a pair of eccentric rings that can be rotated to any toolface setting and to varying degrees of offset from center.



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Deflection of the shaft in the middle results in the deflection of the output shaft carrying the bit in the opposite direction. A computer controlled bias unit automatically detects any slippage of the outer housing and compensates for this by correcting the rig positions in the opposite direction.

Two modes of rotary steering are available with **Geo-Pilot**. In addition to a backup manual mode, in which the tool is pointed and controlled by the directional driller, the **Geo-Span** downlink system allows for automatic steering along a fixed or preprogrammed trajectory without having to interrupt the drilling process. The downlink system confirms acceptance of the commands within 15 seconds.

The battery powered system eliminates reliance on downhole turbine, and increases reliability and maximum bit-run life. Isolation of critical components from wellbore fluids eliminates mud compatibility problems. Downhole diagnostic capabilities provide real-time information about the tool's status and confirmation of operation.

Because the system has the ability to place the wellbore through multiple targets, it can improve recovery from a single well. In one case, using its ability to perform "flat-turn" openhole sidetracks, the system drilled six laterals from two main bores for a North Sea operator.

The openhole sidetracks in the second four-branch lateral were performed while keeping the entire reservoir section within +/- 1 ft of the TVD horizon.

## BAKER HUGHES

**Baker Hughes' AutoTrack Rotary Closed Loop (CL) system** was developed in conjunction with **ENI-AGIP S.p.A.** The **AutoTrack** system has drilled more than 1,000 miles of hole since its commercialization in 1997. The tool is an integrated drilling and formation MWD system that provides directional control.

Like **Geo-Pilot**, **AutoTrack's** downhole guidance system automatically keeps the tool on its preprogrammed course. Well trajectory changes are communicated via downlinking.

**AutoTrack** can be used with rotational speeds up to 300 rpm in temperatures up to 150 degrees centigrade.

The system was used in a horizontal well in the North Sea. A competitor's tool, with a **Baker Hughes MWD** system just above it, was used to drill a reservoir section of the well. The MWD system included the same resistivity and gamma ray sub that is used in the **AutoTrack** assembly.

Another section of the well was drilled with the **AutoTrack** tool. The trajectory of the competitor's rotary steerable tool varied between total vertical depths of approximately 2,619 meters and 2,624 meters.

The **AutoTrack** kept the TVD in a window of +/- 8-in. for a total of 4,383 ft.

## SCHLUMBERGER

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Schlumberger provides a rotary steerable system called the PowerDrive\* 475 that provides rotary steerable drilling in 6-in. holes. The system consists of a control unit containing a valve that remains stationary amid 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 design also uses materials and face contours that reduce valve friction.

The tool 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 lead to longer runs and greater reliability in harsh and abrasive formations.

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 three-dimensional trajectory control. The combination of the 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 several advantages. One is the reliable directional control in doglegs up to 8 degrees per 100 ft.

The tool is the only rotary steerable system capable of a kickoff from vertical.

Schlumberger announced successful field tests of the new slimhole rotary steerable drilling system in April and June, 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 feet per hour.

The 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 saved 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-inch 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. ■