Rotary steerables drill complex wells at lower risk

MUCH MORE COMPLEX well profiles can be drilled with much lower risk with RSS technology. Coupled with better drilling efficiencies, the result can be significantly lower well costs.

The combination of lower risk wells and drilling efficiencies has enabled the industry to maximize reservoir exposure, resulting in a large production benefit to operators. Some wells and fields may not have been economical to drill or develop had it not been for RSS technology.

Rotary steerable drilling technology is well established in the industry following its introduction in the mid-1990s, with commercial use beginning in 1997. R&D of the tools and method began in the early 1990s.

Initially, the industry was calculating the benefits of rotary steerable systems (RSS) in terms of drilling efficiency. Drilling efficiency is still an important factor, however, just as important to the industry are the types of wells that can be drilled with RSS.

"Rotary steerable is probably the most important technology to drilling since top drives," said **Jon Ruszka**, a Drilling Systems Product Manager at **Baker Hughes INTEQ**, Aberdeen.

"We are drilling well profiles now that operators would have shied away from even two or three years ago because they didn't have the confidence to invest in them," he continued. "The geometric complexity of the wells we drill now on a regular basis is light years away from what was done just a few years ago."

The complex well profiles allow operators to access difficult to reach areas of a reservoir, intercepting multiple geological targets and saving the costs to drill individual wells that would have previously been required. RSS technology also results in a lower risk to overspending the AFE.

HYBRID SYSTEM

Baker Hughes INTEQ's RSS is a hybrid system, incorporating parts of both the push-the-bit and point-the-bit RSS, the two methods of steering the bit downhole. Both methods have their strengths and weaknesses.

What really matters, according to the company, is consistent steerability in a wide range of drilling environments with the highest quality wellbore possible.

Push-the-bit RSS steers by applying a side load to the bit, forcing the bit's outer cutting structure and gauge to cut sideways into the formation to drill a curved hole in the desired direction.

Point-the-bit RSS steers by pointing the bit in the desired direction via flexing of the tool inside the housing. The drill bit's face is pointed precisely in the direction to be drilled without side load on the bit.

Baker Hughes INTEQ's AutoTrak rotary steerable system is a hybrid, incorporating parts of both push-the-bit and point-the-bit steering methods to take advantage of each method's strengths.

The company's AutoTrak Rotary Closed Loop System (RCLS) incorporating parts of both methods, permits the system to switch between modes depending upon the immediate requirements.

"The tool has pads on the outside to apply force against the formation that immediately pushes the bit to the side in order to initiate a new trajectory curvature," Mr Ruszka explained.

"Once the curvature is established, the pads pushing against the borehole bend the bottom hole assembly into the curvature so it acts like a point-the-bit system," he continued, "so we initiate the curve with push-the-bit and continue the curve with point-the-bit methods."

COMMUNICATION

In order to reach multiple geological objectives of a reservoir, the RSS needs to know where it is going. Linked into the technology is advanced logging while drilling (LWD) capabilities. Reservoir navigation or geosteering has advanced along with RSS.

"They are two perfectly matched technologies," Mr Ruszka said. "Rotary steerable drilling has brought together the drilling and the G&G groups much closer than they previously were.

"They work together in geosteering the wells into the correct formation and then maintaining the position of the wells with a high degree of accuracy."

While many of the rotary steerable systems have some capability of preprogramming the tool's trajectory on the surface, more important, perhaps, is the capability of communicating with the tool from the surface while it is downhole.

The driller is working closely with geologists and geosteering engineers as the RSS approaches different formations, downlinking with the tool to change the programming if necessary while continuing to drill ahead.

Using LWD provides real-time information to steer the wells to their targets and eliminates having to wait until a wireline log is performed to confirm the location of the well in the reservoir.

The major RSS providers have been investing heavily in LWD to increase its capabilities in order to take advantage of the precise directional drilling capabilities provided by rotary steerable drilling systems.

TROLL FIELD

One of RSS's success stories has been Hydro's Troll field development. INTEQ drilled multilateral horizontal wells with

Rotary steerable systems allow operators to drill more complex well profiles while reducing risk and well costs and increasing drilling efficiency, resulting in maximum reservoir exposure and increased production.

its RSS that had to be accurately positioned within the field's thin reservoir.

"These are large 3D horizontal multilateral wells," Mr Ruszka explained, "and you have to be very accurately positioned relative to the oil/water contact.

"We were steering these wells to within half a meter of accuracy along a very long horizontal length."

The Troll field's reservoir is thin, requiring continuous and precise geosteering to remain within the optimum pay. The reservoir consists of weak sandstone containing very hard calcite inclusions that, when intersected while drilling the lateral drains, can force the drillbit momentarily off course, resulting in a very localized but severe dogleg.

This makes drilling on Troll particularly challenging. Highly specific drilling techniques have been developed between all parties to improve overall performance and increase the amount of reservoir that can be exposed from each well.

The company drilled 7,950 m (26,000 ft) of reservoir in the Block 31/3 Q-21 well 35.5 days ahead of the well plan with an associated cost savings of more than $12 million.

The Troll field likely would not have been as large an economic success without RSS technology, Mr Ruszka noted.

"When they began drilling on the field, rotary steerable was not available. They began drilling with conventional steerable motors, and LWD was incorporated within the motors themselves to bring LWD closer to the bit for better geosteering."

Since rotary steerable became available to Hydro, they now drill almost exclusively with rotary steerable systems, Mr Ruszka noted. The platform is nearing the point where it is slot-constrained, he explained, so Hydro is drilling a lot of multilateral wells with up to five branches on a regular basis.

Initially, Hydro utilized RSS when the well reached the thin reservoir. When they examined the 12 ¼-in. sections they realized the RSS could provide advantages there as well.

"Later they began using rotary steerable in the upper 17 ½-in. hole sections as well," Mr Ruszka said. "They are now using rotary steerables from the 17 ½-in. section through to the 8 ½-in. hole size."

The reason, he noted, is that by using RSS in the upper hole sections, gross ROP is improved and they are assured that the curves are smooth so casing is not worn by the rotating drillstring in subsequent hole sections.

He noted that the estimate of additional production value that rotary steerable systems have delivered to the Toll field is in the region of $6 billion.

"The operator has drilled well over 1 million ft of hole in the Troll field with rotary steerable," Mr Ruszka said. "The field has arguably been an economic success for Hydro because of this type of technology."

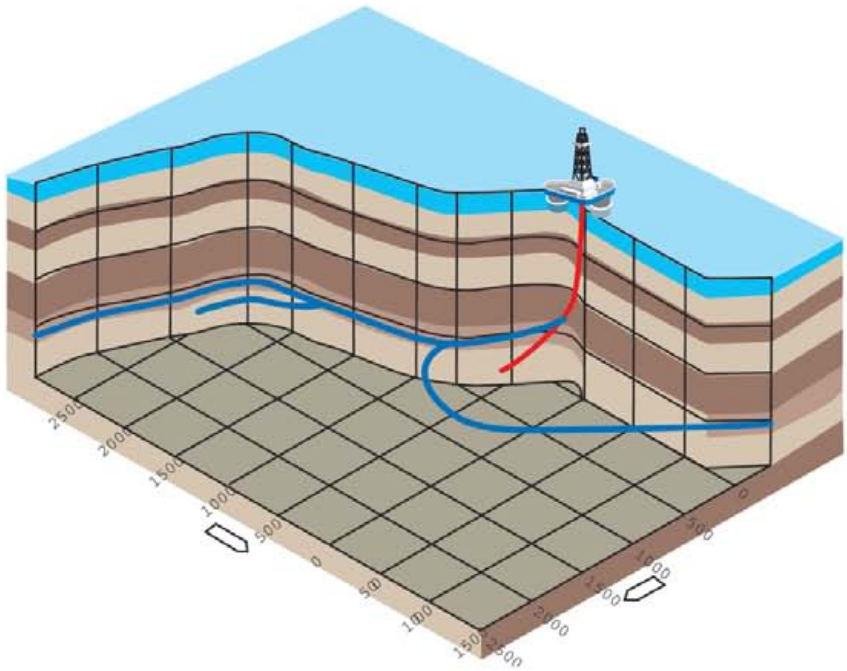
EXTENDED REACH DRILLING

Rotary steerable drilling also aids in drilling extended reach wells, resulting in smooth wellbores that aid in setting casing.

On Sakhalin Island off the east coast of Russia, for example, the company is drilling extended reach wells with RSS that are surpassing 11,000 m, or about 36,000 ft, although they are not necessarily long horizontal wells.

"We have to kick off the well at a relatively shallow depth," Mr Ruszka explained, "and provide a nice smooth build up rate so we are not inducing a lot of torque later in the well.

"There is a long 12 ¼-in. high angle tangent section that finally builds up and intersects the reservoir, which is drained with a horizontal leg," he continued. "Most of the well is getting from the beach to the reservoir offshore."



The multilateral wells in Hydro's Troll field in the North Sea were steered to within 1/2 meter of accuracy along very long horizontal lengths in order to optimally penetrate the very thin formation, requiring continuous and precise geosteering to remain within the optimum pay.

One of the risks involved in extended reach wells is setting the casing. An automated RSS can drill a continuous curve during the build up section and then maintain the tangent in that portion of the well. This provides a smooth borehole to minimize any potential problems installing casing in the curved section.

"Because these wells are so distant," Mr Ruszka said, "we are applying more advanced wellbore positioning techniques to place the wells as precisely as possible."

Logistics is another challenge with the Sakhalin Island wells due to the remote location. As a result, repair and maintenance of the RSS is performed at the rig site. Additionally, the company keeps a contingent of RSS tools available.

The company also drilled a record offshore extended reach well in Hydro's Oseberg field off Norway. The B-47 well recently surpassed 10,000 m in length and was drilled from the main platform as an option to drilling a more costly conventional subsea well.

The reservoir was planned to be drilled in a 5 m thick sand with unstable coal layers above and below, so it was important to optimally position the drain hole to avoid hole problems and ensure optimal production.

The well was drilled in the Tarbert reservoir, however, that reservoir thinned out after drilling 1,500 m. It was decided to change the proposed well path and explore the Etive and Oseberg formations below the Tarbert formation.

At 9,500 m measured depth, the well path was dropped from 90° to less than 60° inclination. New reserves were identified in the Etive and Oseberg formations that might be produced at a later date.

The successful completion of this well was attributed to the close collaboration of a project team that included representatives from all parties.

INCREASING ROP

The company is still focusing on steerable motors as well as RSS, and has combined the two technologies by installing a drilling motor in the BHA above the rotary steerable system.

The drill pipe still rotates continuously plus the system is receiving the benefits of drilling power at the bit as opposed to having to provide the power with a top drive from the surface.

The motor delivers power directly to the bit for higher ROP while the drillpipe is continuously rotated but at a much slower rpm than typically required for rotary steerable drilling.

By establishing the motor's power at the bit and reducing drillstring rpm, drillpipe does not wear out as quickly and minimizes casing damage caused by drillstring rotating at high rpm. The RSS can still steer the bit to the geological target but at higher ROP.

"We have been using AutoTrak X-treme services primarily in the North Sea," Mr Ruszka said. "One well we drilled there has been independently benchmarked as the best drilling performance in its class since records began.

"We see tremendous performance from these new systems in some specific applications," he continued. "and it is an area in which we are very excited."

In Talisman (UK) Limited's well in the North Sea Claymore field, experience showed that rotary drilling is significantly slower than motor-driven drilling in

the CNS Cretaceous formations, rendering RSS uneconomic compared with conventional steerable motor drilling techniques.

When directional work is required, slide drilling with conventional assemblies can be slow and troublesome. However, it was anticipated that this system would increase ROP, making use of the RSS more effective.

The Claymore C78Z well was a sidetrack from an existing producer with a whipstock used as the casing exit method.

Following experience with the 9 ½-in. AutoTrak X-treme on a previous well, it was decided to run the 6 ¾-in. tool in the 8 ½-in. section of the well.

The entire 2,577 ft 8 ½-in. section was drilled in one BHA run. Planned time estimate was based upon anticipated ROP of 27.7 ft/hr, which was actually more than doubled to 61.9 ft/hr.

SMALL TOOLS

The company has recently developed and used a 3 ⅛-in. RSS for small hole sizes of approximately 3 ⅞-in. The 3 ⅛-in. tool was designed specifically for slim hole and re-entry drilling applications.

Smaller OD RSS technology such as Baker Hughes INTEQ's 4 3/4-in. AutoTrak system could offer operators a new enabling technology to extend the life of mature fields.

The company ran the small RSS through 5 ½-in. casing to re-enter and drill a 4 ½-in. hole for Luff Exploration in North Dakota.

This enabling technology could extend the life of mature fields beyond the point where operators believe they need to begin decommissioning a field.

"Once ultra-slim rotary steerable systems gain acceptance, I think a market will develop for them," Mr Ruszka said. "They will mainly be used for re-entry applications in mature fields, and could make a big change in rejuvenating mature fields and delay shutting down production."

Other rotary steerable system providers are also working on ultra-slim RSS.

Other than Baker Hughes INTEQ's 3 ⅛-in. tool, the smallest is a 4 ¾-in system that is now being established for drilling a nominal hole size of about 6-in. ■