Offshore Technology Aims at Lowering Breakeven Economics

From cost-effective RSS to higher bandwidth mud pulse to lower vibration underreamers, service companies are designing tools to meet industry demands.

The deepwater offshore drilling industry is changing with a focus on the “highest-specification assets [that] are at a critical inflection point as few such assets are in the global rig supply,” according to Ensco Plc in its September 2017 investor presentation.

There is an “industry-wide focus on lowering breakeven costs for offshore projects through re-engineering, standardization and simplification,” the company stated.

There will be fewer offshore drillers due to consolidation. Ensco backed up that statement with the completion of the acquisition of Atwood Oceanics Ltd. in early October 2017.

According to the company, “Larger customers [will] contract rigs with service providers that can help to continue improving breakeven economics for offshore projects through technology, innovation and new contracting models.”

Service and manufacturing companies are responding to the call for more cost-efficient and higher performance tools to meet customer demands. The largest advantage offshore operators have to improving drilling operations is data. The more real-time data that is available and leveraged, the more accurate and efficient is the placement of the wellbore.

“We saw the opportunity to develop a high-performance but simple and cost-effective rotary steerable system [RSS] as part of a back-to-basics approach that we’re taking to design tools for the current environment,” said John Clegg, director of R&D and engineering for the Drilling and Evaluation Segment for Weatherford.

The new RSS represents “a very good, competitive option for somebody looking to drill efficiently in the $50 or even sub-$50 oil price environment,” Clegg explained.

Other companies have developed technology for getting usable data to the surface more quickly so the industry can drill longer, smoother laterals and wells with ultra-extended-reach drilling (ERD).

Expanded mud-pulse telemetry

The industry standard for getting data to the surface in a real-time stream is mud-pulse telemetry. As more tools are added for logging-while-drilling (LWD), a larger amount of data needs to be pulsed to the surface.

“What we’ve done is introduced a new pulse system called JetPulse that has a higher data rate that is double or triple the bandwidth we were able to get previously,” said Tim Parker, Sperry Drilling, a Halliburton business line. “We can now use tools that are more data intensive such as the azimuthal lithodensity (ALD) tool, azimuthal acoustic tool or other azimuthal imaging tools that generate a lot of information. Having a faster pulsing system means that the operator doesn’t necessarily have to slow
down the drilling to get good quality data.”

He explained that with a higher data rate an operator can still get good log data to the surface even while drilling a section in less time. “The other aspect is that with a particular drilling speed, by having a higher data rate, you can have a more detailed log. You can get more data points per foot as you’re drilling the well.”

The JetPulse is designed to operate in any kind of mud. “One thing we find is a general principle that applies to telemetry—the deeper you go, the more attenuation of the signal you see. Heavier muds tend to attenuate more than lighter muds. We have found the performance of this new system is actually very consistent as far as depth is concerned,” Parker continued.

There is very little loss of data rate with increasing depth. “We can work in some of the deepest wells that are drilled in the Gulf of Mexico [GoM] to about 30,000 ft,” he added.

The system also is able to maintain a high data rate that is similar to what other systems would get at much shallower depths.

The company also has a new software system that is an add-on to its data acquisition system, which is a more sophisticated filtering and tuning system than the company had before. It helps to detect the pulses more easily as they come to the surface. The new system takes into account the characteristics of the entire drillstring in filtering out drilling noise, he explained.

When the system first begins operation it sends a predetermined sequence that the surface system analyzes and decides how best to handle the subsequent data that comes up from the tool. “It’s like a sort of auto-tuning to take account of variations in the drillstring, depth, etc.” he said. Previously it was a manual system that people on the surface had to monitor and adjust.

The JetPulse is being used for the more high-end markets such as deepwater markets and more mature markets where a lot of tools are being run. In general the customers are happier the more data they have. They appreciate not having to moderate their drilling rate significantly now that there is a higher data rate. The system can provide a good log at typical drilling speeds in the GoM.

“I’ve got examples where we’ve run the JetPulse system with multiple sensors in the string where you can plot the real-time and memory logs next to each other, and it’s very difficult to tell them apart,” Parker emphasized.

Cutter block for underreamer reduces vibration

If there is a limitation to underreamers, it is the cutting structure or what that structure does to the entire bottomhole assembly (BHA). Underreaming operations can be notorious for having high levels of vibration. That is one of the things Schlumberger wanted to address with its Sting-
Block advanced stabilization conical element cutter block along with providing a cutting structure that increases overall durability and allowing it to last longer and drill faster.

The StingBlock cutter is essentially the cutting structure of the Schlumberger Rhino integrated borehole system. There are a few key features that are used on the StingBlock cutter to better stabilize the BHA and improve the overall cutting structure durability. The underreamer has the company’s proprietary staged profile, which helps to better distribute the cutter loads and to stabilize the overall cutting structure element, explained Wiley Long, product champion for StingBlock cutter for Schlumberger.

“You can imagine it as multiple gauge pads as you go up the cutting structure. Increasing that gauge pad area helps smooth out vibrations during underreaming operations. Our experience shows that the majority of damage that occurs on the reamer cutter structure is due to impact damage. For the cutting structure we’ve taken a page out of our bits playbook and incorporated the Stinger conical diamond. The Stinger conical element has a much superior impact resistance than a conventional PDC cutter,” he said.

In a conventional underreaming-while-drilling BHA, the assembly is susceptible to vibration because of the great distance between the two cutting structures drilling simultaneously—the underreamer is typically about 150 ft from the bit. Because of the distance, quite often the tools will be drilling in different kinds of rock, which can generate a lot of vibration into the drillstring, he explained.

What helps reduce vibration are the staged pads that better stabilize the cutting structure. It provides more contact area for the cutting block and the extra level of stability that is needed.

The rows of PDC cutters on its conventional reamers are symmetrical. “Symmetry might sound nice but in things with moving parts it can be susceptible to harmonic vibration levels. With StingBlock cutter we’re creating an alignment with PDC cutters and Stinger elements more broadly distributed across the width,” he noted.

Schlumberger devised a different system that would incorporate two Rhino StingBlock reamers into the same BHA. It is called the Rhino RHE rathole elimination system. “For that system you have your top Rhino reamer in the conventional location above the LWD tool. Your second Rhino reamer would be just above the RSS about 20 ft to 25 ft from the bit,” he continued.

The top reamer would be used while drilling the majority of the interval. Once the bit reaches total depth the upper reamer is deactivated, and the lower reamer is activated. “We can then underream that 120 ft-plus of rathole and eliminate an additional trip to underream that rathole,” he added.

In the MWD and LWD tools there are sensors measuring vibration. In lab tests and field operations the company found the ability of StingBlock cutter to reduce vibration levels.
to bring the sensors close to the formation to get a good measurement,” he continued.

The advantage over a wireline is that the tool is rotating and able to generate those images that are not available from the wireline density tool.

“The deepest we’ve gone so far with this tool is 24,000 ft measured depth [MD]. So far we’ve been working in the range of 12,000 ft to 24,000 ft roughly,” he added.

Parker said Sperry is the only company with these larger size tools.

Running the density tool for real-time data and dip estimation below salt in the larger bore sizes seems to be a more popular application now. “Eliminating the wireline run provides the real savings potential for the customer. They can get the data without having to make a special trip or spending extra time on the rig,” Parker emphasized.

RSS designed for ERD wells

Operators are looking for cost-effective ways to drill faster and longer laterals since the more footage that they can expose, the higher the level of returns, said Juan Restrepo, product champion for RSS for Schlumberger.

“When you measure drilling efficiency, it can be seen in two ways—drilling faster and minimizing the number of BHAs used to drill to the objective. All the development we have had in recent years has to do with how to have the system provide a quality hole for our client in the shortest period of time,” he continued.

There are three points that have to be hit to reach new levels of performance—drill faster, the ability to drill longer wellsbores in the target zone and provide high quality holes. “No matter how far you drill, if you don’t have a hole that can be used, it is going to be a waste of time and money for the whole well construction and production process,” he added.

Schlumberger has added two new members to its PowerDrive RSS family. The PowerDrive Xcel RSS is focused on offshore and ultra-ERD wells, while the PowerDrive Orbit RSS is focused on land operations, including super laterals.

“The ERD wells are getting longer and longer so downhole automation is becoming more critical for the consistent performance of directional tools building micro-tortuosities across the extended lengths reduces the amount of energy required for the actual drilling process,” Restrepo explained.

Each RSS has a distinctive design, but both the PowerDrive Orbit RSS and the PowerDrive Xcel build on their direction and inclination sensors close-to-the-bit to provide automated closed-RSS loops simultaneously on inclination and azimuth. Closing this loop downhole allows us to automatically hold any 3-D orientation vertically and laterally for a given target, minimizing the interaction from the surface in the drilling process for faster penetration rates.

“There are no more commands to be sent to the tool. The tool is going to measure its orientation downhole and do exactly what it needs to keep the target set,” he said. That takes the human out of the equation.
At 350 revolutions per minute, the tool can still measure downhole both inclination and azimuth.

“One of the quests we had [in the design] was to accurately measure the inclination and azimuth dynamically to confidently let the tool decide for itself what to do without requirements from the surface. That is a very important point of this,” he emphasized.

Vibration affects where energy is going in the drillstring. “For drilling performance, characterization of the vibration patterns is critical. Both technologies provide triaxial measurement of shocks and vibration,” Restrepo continued.

The PowerDrive Xcel RSS also was shown to be effective in open-hole and closed-hole sidetracks due to the inclusion of a gyro and a customiz- able bend offset. The tool can measure rotation and stick-and-slip in magnetic interference environments. It also maintains directional control through the zone of exclusion, he added.

**LWD tool designed for 200 C environment**

Operators drilling in the Gulf of Thailand know to expect high bottomhole temperatures (BHT) and high ROPs. One Weatherford customer had drilled several wells in the area very quickly and wanted to use LWD to log the well, however the BHT was around 200 C.

“It has been a real challenge for the industry to produce an LWD tool that operates at 200 C. It requires a very different approach to design, manufacture and then test the electronics in particular to get the tool up to that temperature rating and operate reliably in that kind of environment,” said Weatherford’s Clegg.

“If you look at the inside of the HeatWave Extreme HP/HT LWD tool, it is very different from conventional LWD tools. During the R&D process we worked with die manufacturers and ceramic packaging vendors to combine multiple functions into hybrid modules,” he explained.

After completing the design part of the LWD tool, the company began testing and qualification with very rigorous and extreme tests up to 250 C. “We also did some very extreme excursions from temperatures above 200 C down to below the freezing point and back up again. This simulated the kind of things you’d see if you trip out of a hot reservoir onto a cold deck and then back down,” he continued.

The company also did the same vibration and shock testing as it would on a conventional LWD tool. “The functions of the tool are the same as they would be in a low-temperature tool. We didn’t make any sacrifices in terms of functionality or data quality,” he emphasized.

The tool has a temperature rating of 200 C and a pressure rating of 30,000 psi. Data can be recorded at ROPs up to 720 ft/hr.

Operators appreciate the HP/HT LWD tool because of the accuracy of the service and the ability to maintain calibration of the tool at that kind of temperature, he said. They are also impressed by its ability to drive improvement in performance by providing reliable measurements,” he said.