

# Antistall Tool Reduces Risk in Drilling Difficult Formations

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A new method is now in use to reduce the risk and increase efficiency when drilling difficult formations. The antistall tool makes it possible to drill highly mixed and laminated formations with less risk of severe vibrations and downhole equipment failures. By reducing vibrations, the tool simultaneously improves the rate of penetration (ROP).

Drill bit-induced vibrations that occur during rapid transitions in subsurface formations are hard to predict and therefore equally hard to avoid through the preselection of bits and drilling parameters. The antistall technology is based on a dynamic, self-supported downhole mechanical system that actively controls the bit's depth of cut (DOC) by manipulating the weight on bit (WOB). The system uses the rotary torque as an input control parameter to actively counteract the torsional peak loads and stalls

that are common through sharp transitions and contrasts in the underground. Because of its relatively simple functional principle, the method has proved highly versatile. It is capable of reducing vibrations in a wide range of applications that, in addition to regular rotary drilling, includes reaming and through-tubing milling (Dagestad et al. 2006).

## Continuous Prevention of Bit Stalling

Because it is part of the lower bottom-hole assembly (BHA), the antistall tool can quickly and continuously prevent the bit from stalling and thereby limit the development of severe stick-slip vibrations. The mechanical function of the downhole tool is based on converting the rise in the drilling torque that precedes a stall into an axial contraction that will immediately cut back the WOB. The fast

reduction of weight on the bit reduces the DOC sufficiently to keep the bit rotating. The conversion to the axial contraction takes place through an internal helix and appears as a reduction in the length of the polished, telescopic section seen in Fig. 1. With the contraction, a strong spring and absorber is simultaneously compressed internally in the tool body above the telescopic section. The energy absorbed in the spring is fed back through the system to maintain a steady torsional load. This capability of absorbing and releasing energy makes the system work continuously and with no need for reset.

Fig. 2 shows a downhole recording of torsional (stick-slip) vibrations in a 17½-in. hole where the antistall tool was run in at 2567 m to improve drilling, after an unexpected, difficult formation had caused several bit trips. Except for the antistall tool and a new bit, the BHA was practically identical throughout, and the data showed how the stick-slip vibrations were reduced and the reduction was achieved without much manipulation of surface parameters. The actual stroke needed to keep the bit rotating is a fraction of the telescopic capacity. The purpose of the extensive capacity is to provide the desired antistall effect with a wide range of loads and without the need for specific configurations or time spent on changing surface parameters. Because of its flexibility and ease of operation, antistall technology does not require any service personnel in the field.

## Torque Stability Optimized

From third-party testing and field qualification, the effect on stick-slip and the capability to provide a more stable torsion load on the bit has been documented (Selnes et al. 2008). However, a surpris-



Fig. 1—The antistall tool must be placed within 50 m of the bit. Typically the tool goes on top of the nonmagnetic section or above the underreamer, where applicable. (Photo courtesy of Tomax.)

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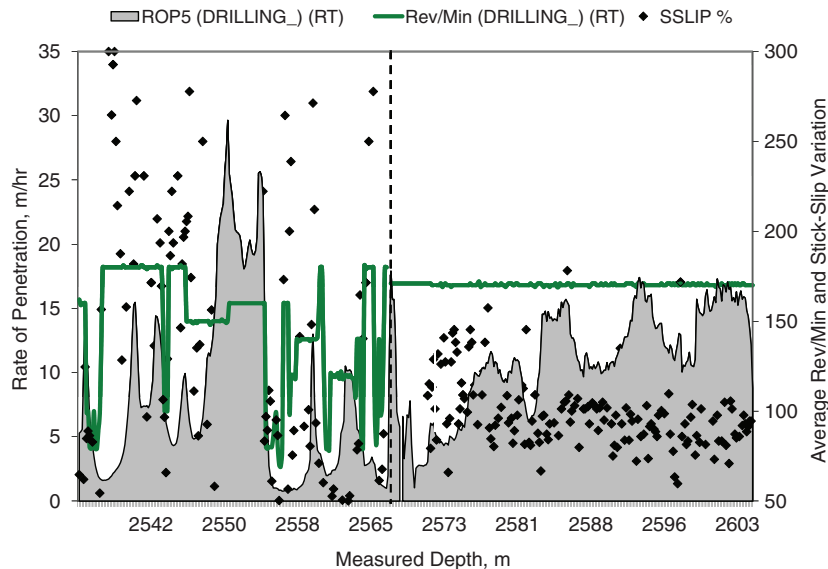
ing factor was the ability of the antistall tool to begin to work just as the cutters were about to stall. With torque stability continuously optimized in this way, there is considerable potential to boost drilling speed. In testing and qualification, drilling speeds have as much as doubled and the improvements have been repeated in the field. The biggest improvements have occurred where reference vibration levels have been highest.

Torsional vibrations can also come from drillstring interaction with the borehole wall. Such vibrations can be strong in high-friction formations such as carbonates. The resulting large variations in angular velocity often saturate the downhole accelerometer readings transmitted from the measurement-while-drilling (MWD) tools and impair the quality of real-time information they provide.

A further complication under these circumstances is that the strongest oscillations often appear as the bottom part of the string goes into compression. As a result, it is impossible to separate oscillations induced by friction or by the bit. If applied in this situation, the closed-loop function of antistall technology will decouple the string oscillations from the bit. This prevents the accumulation of stress and vibrations at the end of the BHA, where advanced rotary steering systems are often located. The antistall tool will also help to stabilize the oscillating input energy to yield the best bit efficiency and ROP results possible under these circumstances.

## Field Results

The technology has been used in a growing number of fields to reduce failures (Reckmann et al. 2010) and improve drilling performance in advanced operations. Both service and operating companies have driven its implementation. **Table 1** shows the distribution of antistall tool experience between the lead rotary steerable systems, including their combination with simultaneous underreaming systems. Comprehensive field studies and more statistical information have provided nominal figures for the vibration mitigation and other effects of the



**Fig. 2—The effect of the antistall tool on downhole stick-slip, ROP, and rotary speed, plotted with an overlay showing the tool run in from a depth of 2567 m.**

new method. One set of statistics (Performance Analysis 2011) was obtained from 78 jobs by the same service contractor through 2010. The results showed that the downhole tool failures caused by vibration were cut in half with antistall technology. Newer numbers including a portion of 2011 showed a further decline. The same statistics also reported improved average ROP results from the use of the antistall tool, with no negative influence observed on any parameter. The analysis concluded with a practical applications table shown in **Table 2**.

From 2010, it was possible to equip the antistall tool with downhole

recorders to measure the actual workload and axial displacements. This helps design engineers to better understand the closed-loop process and improve the method. The functional principle and the operational improvement that result from the dynamic DOC control can have significant impact where drilling challenges are a barrier to predictable timing and cost. Below are more case studies.

**Statoil—Smørbukk South Field (Åsgard), Norwegian Sea.** Smørbukk South is known as the most challenging part of the Åsgard field for drilling.

Manufacturer	Rotary Steerable System (RSS)	RSS Run With Antistall Tool	RSS Run With Antistall Tool and Underreamer
Schlumberger	<i>PowerDrive</i>	122	13
	<i>PowerDrive Exceed</i>	14	
	<i>PowerDrive Vortex</i>	4	
Baker Hughes	<i>AutoTrak</i>	35	8
	<i>AutoTrak X-treme</i>	18	
Halliburton	<i>GeoPilot</i>	141	34
	<i>Geopilot GTX</i>	2	
Weatherford	<i>Revolution</i>	2	0

TABLE 2—RECOMMENDATIONS FOR USE OF ANTISTALL TOOL  
(PERFORMANCE ANALYSIS 2011)

Conditions	Hard Formation	High Shock/ Stick-Slip Expected	Medium Hard Formation	Normal/Soft Formation
Use of Antistall Tool	<i>Highly recommended</i>	<i>Highly recommended</i>	<i>Recommended</i>	<i>Not required</i>

To improve drilling economics, Statoil in 2006 initiated a process to speed up high-pressure/high-temperature lateral drilling through the difficult, abrasive, and partially calcite-cemented sands. The company moved toward a more aggressive bit to lessen the need for high WOB and thereby reduce the side forces and accompanying friction-induced stick-slip and string wear. While successful, it depended on not encountering excessive calcite-cemented sands. To bring the bit safely through the cemented layers, Statoil added the antistall tool. Some friction-induced stick-slip still occurred with the tool. However, the average run length and drilling speed were increased by 15% to 100%, depending on the porosity of the drilled intervals (Kjoglum 2007).

**BP—Azeri-Chirag-Gunashli Field, Azerbaijan.** Although young, the sediments under parts of the Caspian Sea are challenging to drill because of variable compaction and stringers. To reduce formation stress from circulation pressures, drilling typically involves simultaneous underreaming. The contrasting sediments frequently cause torsional vibration and reduced equipment reliability. To decrease vibration, the antistall tool was used. The nominal effect of running the technology in the first well was to reduce drilling time with severe vibrations from 56% in the previous well to 2.2%, comparing the same sections. The figure was then reduced to 1.0% in the same section of the next well (Austbo 2011).

**Large Independent Operator—Oooguruk Field, Alaska North Slope.**

Discovered in 2005, the Oooguruk field was a fast-track project brought on stream three years later. The drilling campaign encountered significant vibration challenges from calcite stringers in the long lateral well sections, which threatened to set back the project schedule. To address this issue, several changes were made and antistall technology was added for the intermediate and lateral sections. This resulted in a great reduction in vibrations and step improvement in reliability, with most sections drilled in one run. A significant increase in ROP was also achieved. The improvements enabled the project to return to schedule (Skjelvik 2011).

**Large Global Operator—UK.** A North Sea operator needed a cost-effective means of removing a number of integrated ball valves that had been installed in the lower production tubing of various wells to isolate pay zones during completion and service. Hunting Welltonic, a coiled tubing service contractor, performed the removal work using a 2 $\frac{7}{8}$ -in. mud motor and a matching-sized antistall tool. Use of the tool had already been established as a coiled tubing “best practice” by a number of area operators. The contractor was able to remove the valve faster than with any other method, experiencing only one-sixth of the restarts typical of the best alternative without an antistall function (Forsyth 2010).

### Conclusion

Field experience gained with the antistall technology suggests that the method can make a significant contribution to improving the cost-effectiveness of

exploration and development drilling. Because the tool reduces vibration in the bottomhole environment, it creates the opportunity to use advanced downhole instrumentation, data communication, and pressure management systems that are vital to achieving continuous improvement in recovery.

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