



# COMPLETING THE CYCLE

Claire Kennedy Platt, Danny Perez, and Steven Isaacks, NOV, USA, discuss how friction reduction technology increases efficiency in every well phase.

**A** recovering industry continues to demand solutions for increased efficiency and reduced costs. Recent advances in friction reduction technology have improved performance in different phases of the well cycle, enabling operators to drill farther than ever before in previously inaccessible areas. Variations of Agitator™ system technology from National Oilwell Varco (NOV) have contributed to success from drilling to abandonment, minimising time per well and enabling operators to maximise results.

## **Drilling in demanding applications**

As shale drilling continues, operators have demanded more powerful and efficient technologies to enable drilling in previously unreachable areas exhibiting high friction. The standard Agitator system was redesigned to optimise energy generation using fewer

system resources. The resulting AgitatorHE (high energy) system maximises energy output, enabling reach in longer laterals and decreasing the amount of time required per well.

In a controlled environment, the AgitatorHE system provided evidence of significant tool efficiency improvements across all objectives when compared to the standard system. The same results have been replicated in the field across the globe in different applications. With identical system setup and running conditions, the HE system generated an average of 25% more energy to break friction, peaking at energy levels 60% or more higher than the standard system with no extra cost in pressure drop. The new optimised pressure pulse generation methodology underpins the high efficiency of the system, giving the tool the ability to output the extra energy required to tackle the toughest applications and complete the longest laterals.

The HE system has achieved solid results in controlled environments and demanding applications compared to the standard system.

### Case study

In December 2017, an Eagle Ford operator in Webb County, Texas, used a 6 ¾ in. AgitatorHE system with a goal of drilling a curve and lateral section to TD while increasing overall ROP. Placed 2173 ft from the bit, the system helped drill an overall interval of 9707 ft in 43.72 on-bottom hours for an average ROP of 222 ft/hr. The combination achieved an average sliding ROP of 66.29 ft/hr and a rotating ROP of 294.31 ft/hr with an on-bottom ROP 70% faster than the offset without an Agitator system. The HE system enabled a 33% faster total on-bottom ROP than the offset of the traditional system.

### Drilling in applications with limited rig pump capacity

Operators in Russia and Saudi Arabia demand a lower pressure tool for applications where the BHA runs shallow and pulsation from the friction reduction system reaches the surface. To answer this demand, a low-pressure version of the high-energy system was developed. The AgitatorHE PLUS delivers equivalent performance to the HE system at 200 - 300 psi for applications that are sensitive to high pressure drop. The lower pressure friction reduction system helps operators drilling in shallow environments by generating a softer pulsation that travels up and down the string at

a lower magnitude, creating a lower effect on equipment and tools lower in the BHA.

Lab testing of the lower pressure friction reduction technology has resulted in good performance, and operators have used the tool with consistent success.

### Case studies

In Q3 2017, an operator in Russia could not continue drilling an 8 ½ in. production hole because of high BHA drag and poor toolface control. They incorporated a 6 ¾ in. HE system into the BHA to reduce friction and improve weight transfer to enable improved drilling efficiency and to finish the section. The combination demonstrated enhanced toolface control, efficient weight transfer, and a reduction in downhole friction, successfully drilling to total depth (TD) with no additional wear on bit. The system saved 7.37 days of rig time. The operator realised cost savings of 21% drilling the production section compared to offset runs without the Agitator system. The BHA with the AgitatorHE system finished production string interval in 18.65 days compared to the 26.02 days in the plan without the system.

Another operator in Russia in Q4 of 2017 set an objective to improve drilling performance. Following a study of proposed well conditions, they aimed at hard lithology horizons and directional difficulty using a combination of the AgitatorHE PLUS system and a Fluidhammer™ performance drilling tool. The combination achieved top-level performance in difficult field directional conditions, geology, and drilling parameters, drilling 47% more than the best offset.



Figure 1. The AgitatorHE system.

### Coiled tubing (CT) operations

The advent of wells that reach depths and laterals of 10 000 ft has increased the need for friction reduction technology in coiled tubing operations. Agitator designs were optimised to maximise the effect of pressure pulses on coiled tubing. Valve assemblies and a power section enable the CT Agitator assembly to create pressure oscillations along the longitudinal axis of a coiled tubing string, reducing downhole friction, improving weight transfer to the BHA, and extending the point of lockup.

Operators have used the technology to improve efficiency and enable deeper coiled tubing intervention activity in coiled tubing milling and intervention operations.

### Case studies

In Q1 2017, an operator in the Delaware Basin in New Mexico had a challenge to decrease operation costs by using the high flow CT Agitator system. The operator used a combination of 2 ¾ in. coil with a 3 ⅛ in. BHA consisting of a dual flapper check valve, hydraulic disconnect, CT Agitator system, high-torque motor, and a 4 ⅝ in. rock bit. The TD for the well was 18 525 ft, the lateral length was 9325 ft, and the plugs were spaced 200 ft apart. An offset well consisted of the same BHA without the system. The solution successfully milled all 44 composite plugs. The system averaged 27 minute plug-to-plug trip times and aided mill times, averaging 6.7 min/plug

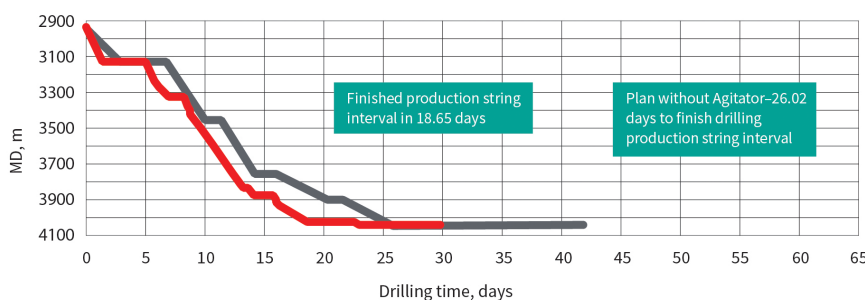


Figure 2. Agitator system drilling time versus plan without Agitator system.

at flow rates between 4.5 - 5 bbls. The solution completed the lateral section in 26 hrs without taking any short trips, cutting the operation time in half compared to the offset well and achieving US\$60 000 in cost savings.

An enhanced system branded the Agitator NEO includes an optimised power section and valve system to reduce additional friction between the OD of CT and the wellbore at the current high flow rates.

An operator in Dimmit County, Texas, in Q1 of 2016 had a challenge to mill through 29 zones and plugs to reach TD on the 9100 ft lateral while pumping 5 bpm using one BHA. Using a 3 in. Agitator NEO from 8195 ft, the operator reached TD at 17 295 ft, an interval of 9100 ft consisting of 29 plugs. The tool helped reduce the friction of the 2 5/8 in. coil, enabling the BHA to reach TD within a 45 hr period with an average mill time of 5.65 min between each plug. On the same pad, the tool drilled a combined total of 40 zones and plugs with an average mill time of 6.01 min/plug while pumping 5 bpm through the BHA.

### **Intervention and abandonment**

Operators have applied the friction reduction technology to increase fishing success. Incorporating the Agitator fishing system in a fishing BHA helps eliminate days wasted jarring and idle fishing, reducing the number of required trips. The technology has proven effective in the retrieval of stuck tubing, casing, and BHAs in cased and open-hole scenarios. The technique has achieved results in fishing operations where other attempts have failed, and has reduced lost-in-hole costs.

NOV continues to seek solutions to bring value to operators in additional applications. Combining the fishing system with hydraulic pulling tools provides further advantages. More than 2500 wells require plug and abandonment in the Norwegian Continental Shelf, which could require several weeks of expensive rig time to plug and abandon a single well in the North Sea. The company is working with

Ardyne and a major operator to develop a system that combines casing vibration and extreme pulling forces via a downhole power tool. The aim of the oscillation and pulling tool BHA is to reduce the significant time spent retrieving intermediate casing strings. The initial phase of this project will integrate several tools used for cutting, oscillating, and pulling the casing in a single BHA. These prototype BHAs will be run on a test rig to validate the concept and to understand in which way frequency can best assist to retrieve casing strings. The tests will offer an opportunity to validate the mathematical models and to understand the driving factors during oscillation-assisted casing retrieval. The test rig setup will be used to find examples of the optimum frequency for releasing stuck casing and whether resonance can be achieved.

The company cooperated with another major North Sea operator, applying expertise in friction reduction and axial oscillation to develop the Valkyrie™ abandonment system, which improves concentric cement coverage to create a permanent, protective barrier. The system reduces the quantity of pipe requiring removal from the well. Following introduction of the abandonment system, operators have tested the cement quality, confirming that rheology samples improved after usage. The system contributed to higher quality cement bonds and minimised channelling and microannulus development. Using the technology has enabled operators to minimise or eliminate rig usage and leave more than 30 000 ft of production tubing permanently in the wellbore.

### **Conclusion**

By aiding operators throughout drilling, completion, intervention, and abandonment, this friction reduction technology has enabled versatility, increasing efficiency in performance and reducing operational costs. As laterals increase to maximise production zones, operators require more powerful and efficient friction reduction solutions. ■