Gliding through extended laterals with water-based fluids

New high-performance water-based drilling fluid system is a cost-effective option for shale wells with high-angle build and long lateral sections.

Invert-emulsion drilling fluid, more commonly referred to as oil-based mud (OBM), is the fluid of choice for drilling extended-lateral wells in the shale plays of North America. The perception is that these wells require a highly inhibitive fluid that could minimize interactions between the fluid and water-sensitive formations such as shale while ensuring high ROP, good lubricity and low potential for stuck pipe.

The fact is that each shale play is different, and the fluid should be tailored for each formation’s characteristics. Shale plays are usually less reactive than claystone but are microfractured and can be very easily destabilized by fluid or filtrate. They require a fluid to drill faster, but not all require high shale inhibition. OBM might appeal to operators that are risk-averse, but the total cost of ownership when drilling with an OBM is much higher compared with a water-based mud (WBM) option.

Drilling with OBM entails:
• increased logistical requirements for bulk fluid transfers;
• high unit cost of fluid, especially when mud losses are encountered; base fluid (diesel) for maintenance; and environmental compliance when OBM cuttings must be hauled off and disposed to a landfill;
• increased cost of contingency materials due to higher chance of mud losses; and
• health and safety compliance costs for spill containment and operator liability for rig personnel.

Fluid development

During the past 14 years several high-performance WBMs (HPWBMs) were developed with the goal of approaching the drilling performance of an OBM. Land operators in North America have trialed inhibitive WBM for replacing OBM to minimize ancillary costs, but highly inhibitive HPWBM proved to be cost-prohibitive for land drilling due to its high unit cost.

It seemed inevitable that a cost-effective water-based drilling fluid that delivered drilling performance similar to OBM would be developed for shale play land drilling. The main requirements of the new drilling fluid system for fit-for-purpose shale play drilling were increased ROP during the horizontal section, good wellbore stability and sufficient shale inhibition for the build section. The scope was to provide a solution that matches or exceeds the drilling performance achieved with OBM, reduces overall drilling costs and minimizes environmental impact.

Performance, cost and environmental factors were concurrently considered during the screening of different chemistries for the main components of a new technology. Learning from the previously developed HPWBM was deemed critical throughout the development, as was a focus on the entire drilling fluid performance spectrum at a lower cost per unit. A differentiation from conventional HPWBM was switching the focus from high shale inhibition—which is not always required for shale play drilling—to increased lubricity for minimizing torque and drag and enabling ROPs that matched or exceeded those provided by an OBM.

The following were determined to be the key criteria:
• high lubricity;
• similar rheology to OBM and referenced HPWBM for improved hole cleaning;
• fit-for-purpose shale inhibition; and
• environmental acceptability for land drilling.

FIGURE 1. The HydraGlyde system provides a flexible drilling solution that fits within rigid HSE constraints. Its novel cost-effective chemistry reduces torque and drag in addition to shale swelling and dispersion.
(Source: Schlumberger)
Successful introduction of new system
In 2015 Schlumberger released the HydraGlyde high-performance water-based drilling fluid system that met the key criteria requirements described above. The new system is specifically designed to improve drillability in extended laterals in shale plays while being easy to deploy, compatible with most additives and resistant to contaminants (Figure 1). By eliminating the waste transportation and disposal costs associated with OBM, the system reduces the operator’s overall cost per barrel of drilling fluid by 40%.

Engineered with three innovative components—HydraSpeed ROP-enhancing primary lubricant, HydraHib shale inhibitor and HydraCap encapsulating additive—the new system provides ROP comparable to that achieved using OBM with excellent hole cleaning and wellbore stability while mitigating HSE and authority for expenditure impact (Figure 2).

The system was initially deployed to drill the build section and the extended laterals for two operators in the Permian Basin.

Case study: reduced torque
The Wolfcamp Formation in the Midland Basin of West Texas contains interbedded shale and limestone that can cause high torque, thus limiting ROP. The curve build section through the Spraberry Formation also presented a challenge because it required higher shale inhibition compared to the lateral. The operator needed to minimize drilling torque in a 4,651-m (15,260-ft) measured-depth well while drilling the curve and a 1,672-m (5,485-ft) lateral throughout the 8.5-in. production interval. In previous wells an inhibitive HPWBM provided the required shale inhibition, but torque limits impaired the rig's overall ability to drill as fast as was possible using an OBM.

The HydraGlyde system included about 1.5 lb/bbl of HydraCap additive to minimize clay dispersion and enhance wellbore integrity, 1% to 2% volume per volume (v/v) of HydraHib inhibitor to provide wellbore stability and 2% to 3% v/v of HydraSpeed lubricant to deliver the required lubricity and mimic an OBM.

The new system met the operator’s expectations by contributing to the successful drilling of the 8.5-in. lateral section with less torque readings on the two first field trial wells in comparison to offset wells previously drilled with an inhibitive HPWBM in the area.

The 8.5-in. production interval was drilled in about five days, making it one of the operator’s fastest drilled wells in the area. Drilling torque was up to 5,000 ft/lb less than seen in offset wells. Subsequent trips out of the hole with the drilling assembly were executed as planned, and neither tight spot issues nor mud losses to formation were observed. The entire section was drilled to total depth with one bit and exhibited a smooth wellbore that was subsequently successfully cased and cemented.

Case study: increased ROP
The first three HydraGlyde applications with the second operator were deployed using the same rig on the same pad location. The operator used an OBM in previous wells drilled in the Midland Basin’s laterals, but the resulting haul-off and cuttings disposal requirements increased the overall well cost. The operator sought a solution to match or exceed the ROP achieved using the OBM without its ancillary cost.

Using the new system, the operator drilled the production interval in 4.38 days, 1.5 times faster than the average time spent drilling wells with offset OBM. The average ROP in the lateral sections (excluding the build section) drilled with the new system was 42.3 m/hr (138.8 ft/hr), a 60% increase compared with the average of seven offset wells drilled with OBM.

Gliding through the extended laterals of the shale plays was made easier through the use of this new water-based drilling fluid system that enabled the operators to achieve desirable drillability, good hole cleaning, low torque and drag, and superior wellbore stability in a cost-efficient manner. The design, selection and concentrations of each component were selected to optimize the performance of the overall system to meet the environmental acceptance criteria required for land drilling applications.

Acknowledgement
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