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A Schlumberger Company

Endura

High-performance brine-compatible drilling fluids

Improve Drilling Rate in the Bakken

Performs better than conventional oil-based mud

Minimizes impacts from saltwater contamination

Enhances hole cleaning

Enables efficient fluid loss control

Endura* high-performance brine-compatible drilling fluids include the EnduraDril* inhibitive divalent water-based drilling fluid and its compatible additives—a suite of products highly compatible with field brine fluids, including Bakken brine.

The EnduraDril fluid has been proved to outperform traditional oil-based muds (OBMs) in the Bakken shale plays. But that's not all: It works with existing brine, is solids free, and because it is saltwater-based, minimizes impacts from saltwater contamination.

As part of this family, additives with proven versatility in the Bakken plays work in tandem with the EnduraDril fluid to lubricate, reduce bit balling, increase ROP, aid in solids removal, improve wellbore stability, and control fluid loss in unconventional environments such as the Bakken.

Endura fluids and additives include

- **EnduraDril** inhibitive divalent water-based drilling fluid
- **EnduraSlide*** divalent water-based lubricant
- **EnduraCap L*** encapsulating polymer additive
- **EnduraSurf*** anticrete and ROP-enhancing additive
- **EnduraTrol*** fluid loss control additive.



APPLICATIONS

- Drilling intermediate and lateral sections in the Bakken shale play

ADVANTAGES

- Is compatible with Bakken base brine
- Improves drilling rate
- Enhances hole cleaning
- Aids in wellbore stability

LIMITATIONS

- Optimal performance in applications with a mud density ≤ 13.5 lb/galUS [1.62 sg]
- Thermal stability ≤ 275 degF [135 degC]

Exceeds performance of traditional OBM in the Bakken

The EnduraDril inhibitive divalent water-based drilling fluid is a low-solids, nondispersed system that is highly compatible with the Bakken base brine. The EnduraDril fluid is versatile in applications for the Bakken plays and is proved to match and exceed the performance of traditional OBM.

Works with existing Bakken brine

EnduraDril fluid chemistry works with existing field water to create a fluid exhibiting inhibitive characteristics and a rheological profile like OBM, yet solids free. Because the EnduraDril fluid is saltwater based, impacts from saltwater contamination are reduced. Depending on the salinity of saltwater inflow, density is minimally impacted. EnduraDril fluid can be weighted up to 13.5 lb/galUS [1.62 sg] with barite if desired to control water flows. Including the EnduraCap L additive in the system enables the mud density to be maintained as close to the base brine density as possible at 9.6 to 10 lb/galUS [1.15 to 1.2 sg].

The combination of DI-TROL* divalent brine system primary viscosifier additive and DI-BALANCE* divalent brine system secondary viscosifier creates the desired rheological profile.

EnduraTrol additive enhances filtration properties.

The EnduraSurf additive prevents bit and BHA balling while improving ROP.

Additives designed specifically for high performance in the Bakken

EnduraSlide divalent water-based lubricant

APPLICATIONS

- Wellbore stability and high-temperature filtration control in onshore operations

ADVANTAGES

- Improved shale stability for faster trips
- Compatibility with high-hardness brines
- Continued functionality in case of the EnduraDril fluid becoming saturated while drilling salt
- Enhanced high-temperature filtration control

LIMITATIONS

- May cause slight increase in rheology

The EnduraSlide lubricant is designed for use with the EnduraDril fluid for drilling unconventional shale prospects in onshore operations. For lubricity and wellbore stability, 2 to 5 vol% of EnduraSlide lubricant should be added directly to the active circulating system at or near the pump suction over one circulation period. After the initial treatment, the product can be added or injected at the pump suction during drilling. The injection rate varies according to hole size, pump rate, dilution rates, and ROP.

EnduraCap L encapsulating polymer additive

APPLICATIONS

- Water and brine solutions
- Clear water to low-solids drilling

ADVANTAGES

- Greatly enhances the removal of drill solids
- Improves ROP

LIMITATIONS

- Hardness greater than 200 mg/L may require product concentrations toward the upper end of the recommended product concentration
- Working temperature ≤ 400 degF [≤ 204.4 degC]

The EnduraCap L additive is ideally suited for water and brine solutions. Normal concentrations of EnduraCap L additive range from 0.03 to 0.10 galUS/bbl with a maintenance treatment level of 1.0 to 4.0 galUS [3.79 to 15.14 L] for every 100 ft [30.48 m] of hole drilled.

EnduraSurf anticrete and ROP-enhancing additive

APPLICATIONS

- Onshore unconventional drilling ROP enhancement for the EnduraDril fluid

ADVANTAGES

- Contains surfactant metal-wetting agents that reduce the potential for bit and BHA balling
- Effectively increases ROP

LIMITATIONS

- Performance may decline if the material is not added continuously in sufficient concentration while drilling

The EnduraSurf additive is designed for the EnduraDril fluid for unconventional drilling prospects in onshore operations. For ROP enhancement, 1 to 3 vol% of EnduraSurf additive should be added directly to the mud system at or near the pump suction over one circulation period. Ideally, the initial treatment should be made prior to drilling out the casing shoe or before entering the open hole while the bit and BHA are clean. If required after initial treatment, the product may be continually added or injected into the mud stream at the pump suction while drilling. The injection rate will vary according to hole size, pump rate, dilution rates, formation type, and ROP.



Case Study

EnduraDril Fluid Improves ROP and Reduces Drilling Hours by 25%, Bakken

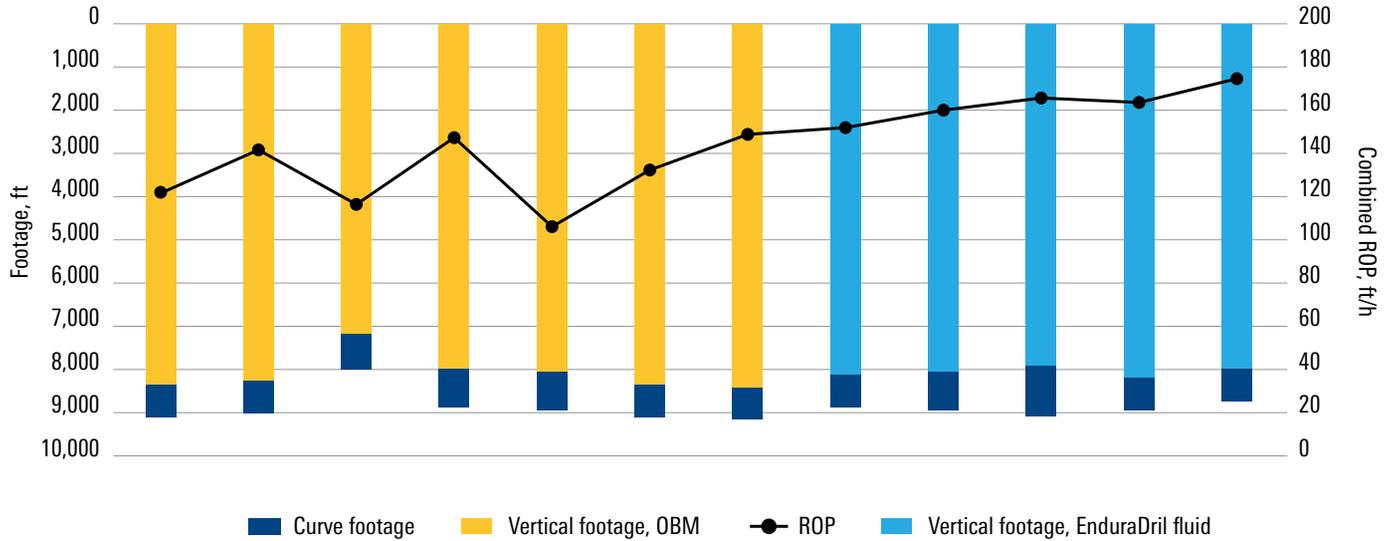
Produced-brine-based fluid outperforms OBM in the vertical section and mimics OBM in the curve while eliminating a bit trip.

A Bakken operator wanted to drill the entire intermediate section of a well with a brine-based water-based mud (WBM) rather than using OBM. However, due to high divalent ion content, field water makes drilling the intermediate section very difficult using traditional WBM products. In addition, saltwater flows are frequently encountered in the Bakken, and OBM is less capable of handling saltwater flows because saltwater intrusion disrupts rheological properties and emulsion stability of oil-based fluids.

Schlumberger recommended using the EnduraDril fluid to drill both the vertical and the curve for these wells. EnduraDril fluid chemistry works with produced water to create a rheological profile like that of OBM but is free of solids, unlike OBM weighted with barite.

Fourteen intermediate sections were drilled using the EnduraDril fluid, and one trip per well was eliminated. ROPs increased approximately 25% and on-bottom hours were reduced 24% compared with the most recent offset wells drilled with OBM. ROPs from the surface shoe to the kickoff point were as much as 66% higher in a well-to-well comparison with wells drilled using OBM. The result was faster and more efficient drilling of intermediate sections with no reduction in wellbore quality or stability. The operator's total costs for drilling fluid, rig time, solids control, disposal, and haul-off to drill the intermediate were reduced by 30%.

**Combined Vertical and Curve ROP,
OBM vs. EnduraDril Fluid**



Across consecutive wells, the EnduraDril fluid continuously outperformed OBM.

Endura

High-performance brine-compatible drilling fluids



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