MI SWACO
A Schlumberger Company

DIPRO

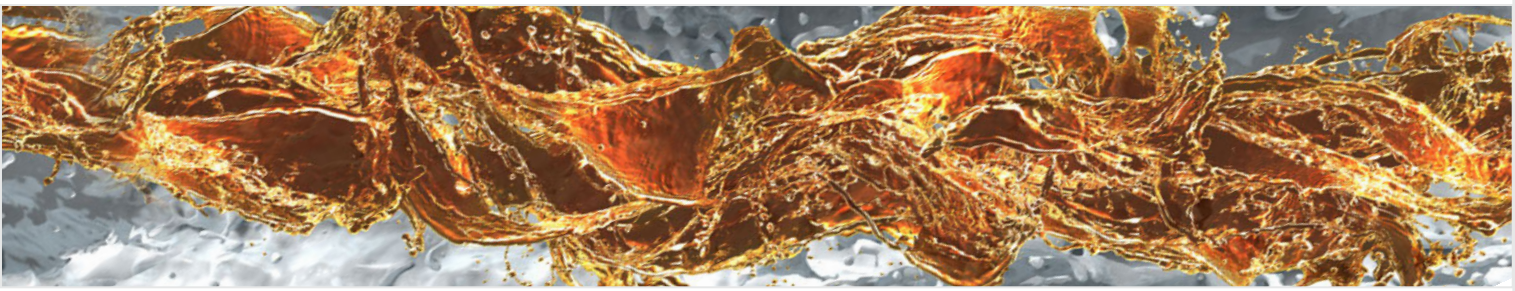
New generation aqueous-base or water-miscible insulating packer fluid for deepwater, low-temperature flow assurance

DIPRO: Premium divalent-brine base reservoir drill-in fluid system

Traditionally, creating reservoir drill-in fluids (RDF) for divalent brines has been a challenge. The biopolymers generally used in RDFs are not compatible with divalent brines such as calcium chloride, calcium bromide, zinc bromide or associated blends. However, the DIPRO reservoir drill-in fluid system from M-I SWACO creates a biopolymer-free RDF that provides optimum performance in a divalent environment.

Biopolymers react in divalent brines to create unwanted and uncontrollable rheological profiles that can result in excessive equivalent circulating densities and poor hole cleaning suspension properties. Biopolymers also become part of the filter cake with standard starch and calcium carbonate bridging agents. The use of biopolymers makes filter cakes more rigid and difficult to remove after drilling and when the well is being completed.

Biopolymer-free drill-in fluid system enhances drilling while simplifying completion



Features

- Biopolymer-free
- Divalent base brine
- Starch complexes
- Four primary components
- Tight filtration control
- Low solids content at high density

Benefits

- Desirable rheological profile that produces lower ECDs
- High density, inhibitive environment
- Provides tremendous lubricity for a water-base fluid
- Simple filtercake destruction more uniform cleanup, fluid reclamation
- Easy to engineer for desired properties / operations
- Minimal formation damage
- Compatible with wide variety of open-hole completions
- Can be used in coil tubing clean-outs and other workover operations

The DIPRO reservoir drill-in fluid system (RDF) avoids these problems by eliminating the biopolymer component. Instead, the DIPRO fluid system uses DI-TROL dual functioning starch together with the DI-BALANCE viscosity enhancing additive to create a desirable rheological profile and an easily degradable filter cake. The rheological profile can be readily adjusted by changing the ratio of the DI-TROL additive and DI-BALANCE additive. DI-TROL additive combined with a properly selected SAFE-CARB bridging agent additive provides excellent fluid loss control in divalent brines. A small amount of DI-BALANCE additive begins to generate desirable low shear rate viscosity (LSRV). Additional complexing agent further enhances LSRV without impacting the plastic viscosity of the fluid.

Standard DIPRO fluid system additives are formulated with four components – base brine, DI-TROL dual functioning starch additive, DI-BALANCE viscosity enhancing additive and SAFE-CARB bridging agent additive. They can be created with divalent brines from 10.8 lb/gal (1.3 sg) to 17.0 lb/gal (2.04 sg). Pure brines or blends of the brines can be used. A higher concentration of divalent ions provides the most durable fluids. DIPRO fluid systems are effective to 250 degF (121 degC) and can be thermally stabilized to greater than 300 degF (150 degC) using a variety of buffering agents and thermal stabilizers.

The starch and calcium carbonate based filter cake is easily destroyed with weak acids or chelant solutions. This characteristic makes DIPRO fluid system suitable for a wide variety of open-hole completions, including barefoot, premium standalone screens and open-hole gravel packs. The starch-based chemistry also permits the whole fluid to be readily broken down to recover the high-value base brine.

The basic components meet environmental standards for both the North Sea and the Gulf of Mexico when utilizing an approved brine.

DIPRO LD: Stretching the density envelope of DIPRO fluid system

With the tremendous global success of the DIPRO fluid system, a solution was sought to extend the DIPRO fluid system to lower densities. Even low concentrations of divalent ions can create problems with biopolymers. Severe problems also will occur if a low-density system needs to be weighted up for well control or wellbore instability issues. The added divalent salt for weight up will further complex the biopolymer.

The DIPRO LD fluid allows biopolymer-free RDF systems to be created with divalent brine densities from 9.4 lb/gal (1.13 sg) to 10.8 lb/gal (1.3 sg). In addition to the four products used in a conventional DIPRO fluid system, DI-LOK and DI-PLEX additives enhance the divalent ion concentration and provide increased surface area to supplement LSRV development. The solubility of these products is controlled to provide a proper balance of soluble and insoluble divalent particles.

The DIPRO LD fluid maintains the same controllable rheological profile and destructible filter cake as a conventional DIPRO fluid system. Although the divalent base brine can still be reclaimed from a DIPRO LD fluid, it is usually not economical to do so.

DIRPO reservoir drill-in fluid system proves itself in the field

Ghana

The Situation

To augment the production in a deepwater field in Ghana, an operator decided to drill and complete the first horizontal open-hole gravel pack well. Reactive shale, carbonate scaling, and a relatively narrow density window were the main challenges while maximizing production was the main objective.

The Solution

A 10.3 lb/gal (1.24 sg) DIPRO LD fluid system was designed with a proper rheological profile to clean the hole and keep ECD below 11.5 lb/gal (1.38 sg) with a maximum flow rate of 600 gal/min. In addition the system also was designed to inhibit interbedded shales as well as avoid scaling with formation fluids during drilling and completion operations. Due to the fluid composition, it also was approved for discharge to the sea.

The Results

A 1,100 ft (335 m) of open hole length was drilled without any problems. DI-LOK and DI-PLEX additives helped maintain very stable fluid properties throughout the interval. No dilution was required to maintain drilled solids below 2%v/v or to treat excessive rheology while drilling. The well was completed with 100% placement of a 12/18 alpha beta gravel pack. BREAKDOWN-HD† breaker was post spotted across the interval with full coverage of the open hole. The well was in production 14 days after spotting the BREAKDOWN-HD breaker. The oil production rate and drawdown pressure highly exceeded the client expectation. The skin values of the open hole vary between -2 and 2.

Norway, Norwegian Sea

The Situation

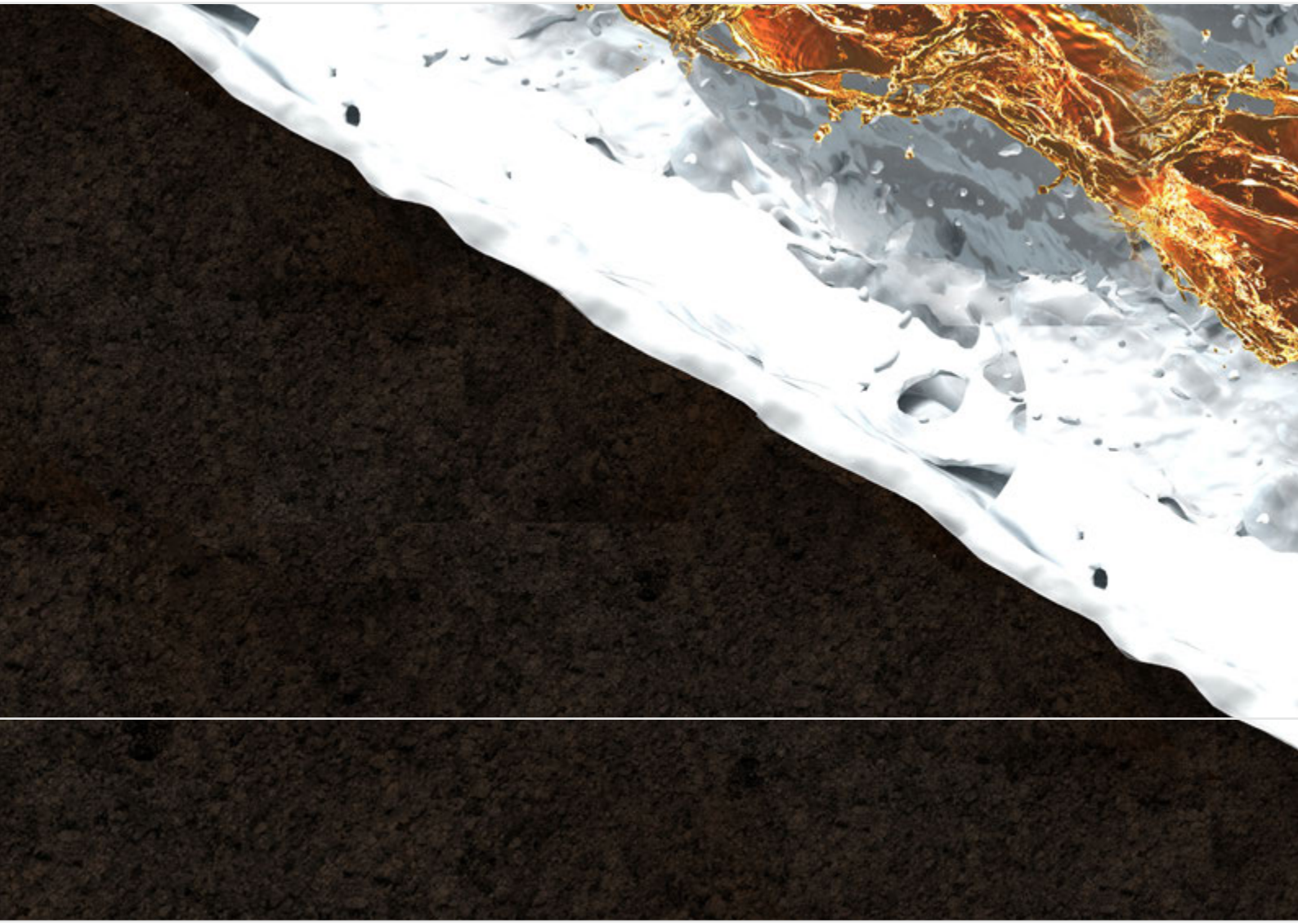
A Norwegian Sea operator wanted to complete a producer well with an open-hole gravel pack. The density requirement would be 12.8 lb/gal (1.54 sg), which would require the use of a divalent brine. The fluid would also have to be compatible with the reservoir rock. The fluid also would have to be mixed and function in a cold environment.

The Solution

The DIPRO fluid system was chosen to be the reservoir drill-in fluid to drill the reservoir section, as it met the density requirement and works well in heavier divalent brines. Testing was performed by the M-I SWACO Formation Damage Laboratory in Stavanger, Norway, to confirm the compatibility of the DIPRO fluid system with the reservoir rock. A cold environment mixing procedure was also developed in the Stavanger laboratories as heat would not be available for mixing the system.

The Result

The 12.8 lb/gal (1.54 sg) DIPRO fluid system was mixed at Norway's Mongstad facility using the Stavanger designed formulation and procedure for a cold environment. The reservoir section was successfully drilled with the DIPRO fluid system. The maximum ECD recorded was 13.7 lb/gal (1.64 SG). The sand control screens were run to the desired depth without any problems and the reservoir section was gravel packed. The DIPRO fluid system met performance expectations during drilling, completion and production.



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