Synthetic drilling fluid meets deepwater challenge

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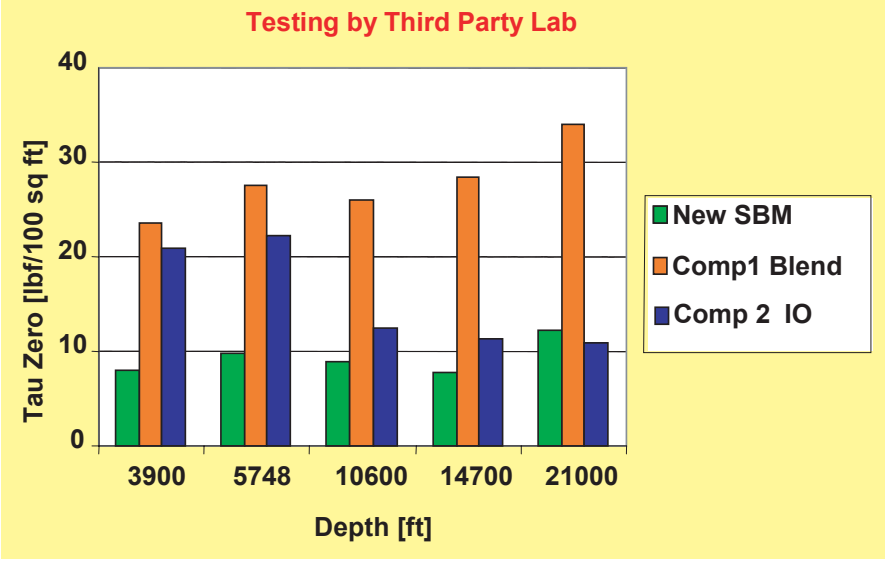
IN EARLY 2001, the United States Environmental Protection Agency (EPA) introduced a new set of guidelines aimed at controlling offshore discharges.

Although previous regulations were already established concerning water-based fluids and other materials, the new regulation was the first to specifically address the use and discharge of synthetic-based fluids (SBFs).

Given supply issues and the technical challenges presented by increasing deepwater operations, new SBF blends and chemistries were researched to help ensure compliance, while satisfying technical requirements.



Performance of the ester/olefin blend system compared to an alternative blend and also an IO. Note how the ester/olefin blend maintains a stable Tau 0 across a range of temperatures whereas the alternatives either thin or thicken with temperature increase.

The EPA identified two synthetic fluid standards, a C1618 IO and a vegetable ester, making the blending of synthetic-based materials relatively easy.

The challenge was to develop a synthetic fluid that would offer outstanding technical performance in both shelf and deepwater environments.

The outcome of this research is a new concept in invert chemistry and design; one that is based on emulsion technology, not on traditional treated clay and lignite-based invert chemistry.

This step-change in technology has resulted in amazing performances that were unheard of two years ago.

THE ENVIRONMENTAL CHALLENGE

The new EPA general discharge permit contained several modifications designed to address the increased use of SBF in the Gulf of Mexico observed throughout the 1990s.

One of the greatest challenges faced with the new permit was the requirement to comply with strict new controls on the type of fluids that could be used and discharged on drill cuttings, all the while maintaining the track record of continuous improvements in fluids that had previously been maintained in the Gulf of Mexico.

From a fluid design perspective, the new environmental rules focused on the base fluid stock limitations.

These limitations declared that unblended linear paraffins and linear alpha olefins previously utilized in the Gulf of Mexico could not be used because the paraffins showed insufficient biodegradation.

The linear alpha olefins showed a toxicity that was slightly too high to pass the toxicity limitation.

The challenge was to invent an innovative fluid without significantly increasing the cost while improving performance.

Blends are acceptable to EPA if they pass the stock limitations.

Most drilling fluid companies have used blends of paraffins, olefins and esters in response to the guidelines for a balance between technical requirements, cost, and environmental performance.

Paraffins were not used, even in small quantities, because of their toxicity despite their lower cost when compared to olefins and esters.

THE TECHNICAL CHALLENGE

In addition to satisfying the environmental regulations, a fluid design was needed that could also answer the challenges of operators moving into deeper waters.

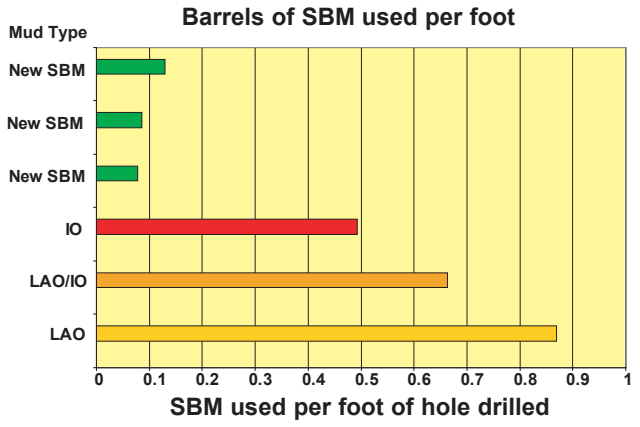
With increasing challenges included complex well configurations in terms of temperature, pressure and well complexity.

Olefins and low-viscosity esters had met this challenge in the past. To help ensure compliance with technical and base fluid volume supply capabilities, an optimal blend of materials was prepared.

It was clear that it would be difficult to find a set of additives that would be technically compatible with the chemistries of esters and olefins in a base fluid, while still ensuring that the final drilling fluid would meet environmental testing requirements.

The final answer was found in the form of a totally redeveloped system. Through research, it was determined that eliminating organophilic clay and lignite from the formulation could greatly reduce viscosities in cold water environments.

The result of the fluid design was an emulsion-based chemistry that provided excellent properties and stability.



Fluid losses with the new blended fluid compared with offset wells drilled with IO or LAO or LAO/IO.

The ester content of the base fluid allows for utilization of specialized thinners that can provide flatter profiles between cold water and downhole rheologies and aids in the development of a novel emulsion structure that gives fragile gels.

The fragile gel structure has been verified and recorded while drilling with the new system.

Pressure while drilling (PWD) measurements indicate that gel strengths are fragile under downhole conditions with little or no spike seen when breaking circulation.

This is important in preventing induced fractures and initiating fluid losses to the formation. This phenomenon has led to increased confidence in the extension of casing points and has greatly reduced fluid loss while drilling, running casing and cementing.

Additionally, it provides the opportunity to improve cement jobs and reduce remedial work by having better fluid displacement.

No barite sag has been recorded on any well to date with the new system. Barite sag caused many problems in the Gulf of Mexico prior to development of this fluid, due to barite "falling out" of the fluid.

Barite sag is especially significant on long horizontal or near horizontal sections and should be avoided at all costs.

In numerous cases, equivalent circulating densities (ECDs) while drilling and circulating have been noted as being as much as 0.1 - 0.4 ppg lower than offset wells drilled with IO base fluids.

The recorded fluid loss and consumption has been much less than previously seen with other synthetics, which has important environmental and economic features.

MET THE CHALLENGES?

The fluid has been readily adopted by numerous operators in the Gulf of Mexico, both majors and independents.

Since the introduction of the new system, the ester/olefin blend is our most commonly provided synthetic SBF in the Gulf of Mexico.

To date, the blend has been used to drill over 70 wells in the Gulf of Mexico with a fairly even split between shelf and deepwater.

The fluid offers some of the lowest viscosities of any NAF system available in the Gulf of Mexico.

The fluid has been used in water depths of over 8,000 ft as well as on shelf applications up to 350ºF.

Since the full regulations came into force, operators using the new blended system have seen compliance in 108 out of 110 field mud sediment toxicity tests.

In both of these cases, the noncompliance was not the result of the drilling fluid itself, but was due to contamination of the fluid from other sources.

REFERENCE

US-EPA (2001) NPDES General Permit for New and Existing Sources in the Offshore Subcategory of the Oil and Gas Extraction Category for the Western Portion of the Outer Continental Shelf of the Gulf of Mexico (GMG290000) - 66 Fed. Reg. No. 243, p. 65209, December 18, 2001.