Drilling and completion fluids

SPE/IADC 52813

"New Open-Hole displacement Procedure Dramatically Reduces Loss of synthetic fluid in Deepwater GOM"

Synthetic drilling fluids have evolved into the system of choice for deepwater drilling, particularly in the Gulf of Mexico. As these systems are proportionally more expensive than their traditional counterparts, the loss of even a few barrels can impact well economics significantly. Historically, it has been commonplace to leave hundreds of barrels of synthetic drilling fluid in the wellbore during open-hole displacements. Attempts to retrieve synthetic muds with water-base systems have proved counterproductive. When exposed to water-base muds in open hole, the formation becomes extremely unstable and will literally cave in, resulting in a number of operational problems.

This paper describes the development and application of a new displacement procedure and a modified water-base mud that successfully recovered 961 bbl of synthetic mud on the Manatee project in the deepwater Gulf of Mexico. When compared directly with conventional open-hole completions in the deepwater Gulf of Mexico, the new procedure resulted in a savings of $175,000. Furthermore, no additional rig time was required to condition the water-base system used in the successful open-hole displacement. More importantly, the wellbore remained stable and no problems were encountered while tripping through the 4,462-ft of open hole exposed to the reengineered water-base fluid system.

The authors will describe both the new procedure, which included a casing shoe with an extremely high lead-off test and realigned pumps, and the new 15 lb./gal water-base displacement fluid. The modified system was both inhibitive to reactive shades and could also withstand the contamination effects of the calcium emulsifier package and its application in more than 55 wells in the Gulf of Thailand. Extensive laboratory tests, the introduction of a completely new fluid loss reducer (stable in excess of 450°F) and a low end rheology modifier will be examined in detail.

This paper discusses the development of the lime-free emulsifier package and its application in more than 55 wells in the Gulf of Thailand. Extensive laboratory tests, the introduction of a completely new fluid loss reducer (stable in excess of 450°F) and a low end rheology modifier will be examined in detail.

Further, the paper discusses the drilling of more than 400 wells using the various invert systems preceding the lime-free system. Several problems with the earlier generation systems prompted the development of the cost-effective lime-free system.

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"Novel Lime-Free HTHP Drilling fluid system Applied Successfully in Gulf of Thailand"

A lime-free, high-temperature invert emulsion drilling fluid that has been developed and applied successfully on several wells in the Gulf of Thailand. The subject drilling program was in a field with downhole temperatures of 430°F. The fluid is run with a pH of less than 7.0, which is accomplished with the introduction of 1 ppb of citric acid and the elimination of the alkaline source (lime).

The fluid was developed to allow the operator to log CO2 formation gas at the surface by utilizing a conventional "mud logging" unit. The ability to log CO2 gas with surface equipment eliminates the wireline RFT logging runs. This would provide significant savings during the course of an extensive drilling program.

This paper discusses the development of the lime-free emulsifier package and its application in more than 55 wells in the Gulf of Thailand. Extensive laboratory tests, the introduction of a completely new fluid loss reducer (stable in excess of 450°F) and a low end rheology modifier will be examined in detail.

Further, the paper discusses the drilling of more than 400 wells using the various invert systems preceding the lime-free system. Several problems with the earlier generation systems prompted the development of the cost-effective lime-free system.
“Dow n-Hole Simulation Cell for Measurement of Lubricity and Differential Pressure Sticking”

Extended reach and horizontal wells through depleted reservoirs represent major challenges to the well design engineers. Realistic design limits imposed by lubricity and differential pressure sticking must be established to ensure well success. Drilling fluid type and composition are important design variables for purpose of reducing lubricity (torque and drag) and establish allowable pressure differentials. Better understanding of the mechanism of differential pressure sticking and proper evaluation of the lubricating characteristics of different drilling fluid systems, under simulated down-hole conditions, are needed to determine optimum design and operational parameters. A specially designed fully automated downhole, simulation cell permits accurate and reproducible measurements of the coefficient of friction between drillstring and mud filter coke and differential pressure sticking pull-out force. Filter cake pore pressure and permeability together with axial and radial forces as a function of time are also measured. Testing principles are based on cylindrical captors (drillstring) equipped with sensors (rotational for lubricity and non-rotational with axial motion for differential pressure sticking). Displacement into ft cylindrical filter cake (wellbore wall) is made automatically through lateral motion of the measurement cell. The main advantage of this apparatus to that ell pressure and force sensors are located inside the cell, allowing for direct measurements. Both water and 90 based fluids can be tested at dynamic pressure differentials of up to 100 bar. A soda of lubricity and differential pressure sticking tests have been conducted. Test data are used to evaluate the differential pressure sticking potential and lubricity of different drilling fluids. Date generated have assisted in understanding the fundamental physics of differential pressure sticking and form the basis for validation of a differential pressure sticking model. This paper describes specifications and measurement principles of the purpose built down-hole simulation cell. Examples of test date are also presented.

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“OneStep Enzyme Treatment Greatly Enhances Production Capacity on Horizontal and High Angle Completions”

Horizontal, high angle, multilateral and open hole well completions are becoming more and more common in the oil industry. Drilling mud systems, known as drill-in fluids, are utilized during the drilling of many of these wells. The fluids are designed to build a durable filter cake along the formation face, effectively controlling fluid losses to the zone during drilling. The drill-in fluids are typically comprised of starch, xanthan and/or cellulose polymers (or a combination of several of these) along with particulates such as sized calcium carbonate or salt. This filter cake impairment must be eliminated to fully realize the maximum production potential of the completion. Past approaches to remove the filter cake include the application of acids and/or oxidizer breaker systems, however the results indicate lower than anticipated well productivities.

Previous laboratory and field work has demonstrated that drill-in filter cake damage can be effectively removed through the application of a newly developed technique incorporating an enzyme based polymer degradation system. The enzyme treatment is carefully designed to degrade the starch, xanthan or cellulose based drill-in fluid. Follow-up acid work can then be performed to remove salt and/or carbonate particulates. This “two step” process of a separate enzyme and acid treatment, although effective, may be unnecessary in some cases. A “one step” method is presented.

The wells evaluated in this study were drilled or completed using a starch and xanthan polymer fluid and calcium carbonate particles. Lab testing and experience with these fluids have shown that insufficient polymer degradation can significantly reduce flow capacity in the near wellbore area, leading to reduced well productivity or injectivity. Acid and/or oxidizer breaker treatments alone have shown to be marginally successful.

This paper will focus on a “one step” enzyme treatment to both remove the filter cake polymer damage and calcium carbonate material in one effective treatment. Laboratory data and case histories are presented to show that this “one step” process is less costly than previous methods used in other areas of the world and has been used to treat long comple-

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