

Engineered Spacers for Improved Zonal Isolation

■ Customized chemistry enhances drilling fluid removal prior to cementing.

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During OTC 2015, Schlumberger is featuring its new CemPRIME engineered chemistry spacer, designed to remove drilling fluids more effectively prior to cementing. Contact with mud residue might prevent cement slurry from setting properly or adhering tightly to casing and formation. The results of an inadequate cement job can include stimulation out of zone, loss of hydrocarbons into lower pressure permeable formations, casing corrosion and blowouts.

To remove mud, a spacer is pumped between the drilling fluid and cement slurry to clean the well surfaces after drilling and casing placement. These spacers are water-based fluids with a combination of additives such as surfactants and/or solvents.

In recent years, drilling fluid chemistries have evolved rapidly to meet the needs of ever-more demanding wells such as those in high-temperature environments. An increasing variety of nonaqueous fluids (NAFs) have been incorporated to enhance well construction. However, while these might boost drilling performance, they can be more difficult to remove from the well.

An additional challenge that can impact zonal isolation is that a portion of the cement slurry is typically contaminated with between 5% and 10% spacer fluid. Many spacer chemistries can affect properties such as cement thickening time, rheology and compressive strength. Therefore, it is vital that spacers not only remove the maximum amount of drilling fluid but also have a minimal negative impact on cement properties.

The compositions of drilling muds, especially NAFs, vary widely, so spacers are usually designed and tested for their effectiveness on a case-by-case basis. American Petroleum Institute, International Organization for Standardization and other industry recommended practices exist for evaluating the suitability of spacers; however, several of these suffer from lack of reproducibility. Furthermore, some apply only for well conditions below 85 C (185 F), while many cement jobs are being performed with bottomhole temperatures up to 150 C (302 F).

Schlumberger has used improved laboratory procedures and equipment to improve the reliability and repeatability of spacer evaluation, including testing under pressure and at temperatures above 85 C. Using these improved experimental methods, the company performed in excess of 3,000 different tests on more than 200 blends of surfactants and solvents. A statistical experimental design process known as response surface methodology was applied to the test results to select optimum spacer chemistry as a function of base oil, salinity and temperature conditions in a well.

The advanced laboratory testing and analysis provided the foundation for development of the CemPRIME engi-



The CemPRIME engineered chemistry spacer is customized based on specific wellbore conditions and other pertinent selection criteria. (Image courtesy of Schlumberger)

neered chemistry spacer. This is a customized package designed and blended based on specific well conditions and considering temperature, NAF base oil type and salt concentration in the spacer. The CemPRIME spacer is compatible with cement slurries and NAFs and does not deteriorate cement thickening time or compressive strength development. The spacer surfactants and solvents act as effective cleaners and demulsifiers in a wide range of temperatures, base oils and spacer salinity. Results are repeatable and robust due to the improved laboratory protocols and apparatus used to measure spacer performance.

Based on these and other comparisons, Mubadala tested the new spacer while cementing a producing section of its Jasmine D-28 well. Zonal isolation was confirmed by cement bond logging and ultrasonic imaging, and top-of-cement was located as planned. Use of the engineered spacer had zero effect on job execution. As a result of this successful field trial, Mubadala adopted the new formulation for additional cement jobs in the Jasmine Field.

To learn more about Schlumberger mud removal and spacer fluids, go to slb.com/CemPRIME or visit Schlumberger at booth 4541. ■

Mubadala Petroleum implemented the CemPRIME spacer to improve mud removal efficiency in development wells in its Jasmine Field in the Gulf of Thailand. More than 100 wells have been drilled in the field with oil production coming from sandstone reservoirs with bottomhole temperatures up to 105 C (221 F). In recent years, evaluation of the quality of cement jobs in production sections has indicated poor zonal isolation, with spacer effectiveness considered as a potential cause. In certain cases, NAF residue is suspected to have affected spacer placement and set properties.

The operator sought to assess and improve its spacer performance. Drilling fluid samples were sent to a regional laboratory to determine the optimum spacer formulation. Tests using the new solution delivered a twofold increase in cleaning efficiency compared with the spacer used previously. When cement was contaminated with 10% spacer, the previous formulation modified its compressive strength by 40% over a 24-hour period while the engineered spacer had essentially no effect.