Resultados

SOLID LUBRICANTS

Drilling smoothly saves time

"I have a dream of someday in the near future doing away with oil-base muds due to the fact that we are damaging our country's environment. Our nation has existed for 5,000 years, and we need to intelligently implement new environmentally safe technologies. If we close our minds to new ideas we close our minds to our futures."
– Ahmed M. Dif Alla, manager of drilling for The Egyptian General Petroleum Corp.

By Well Construction Technology Editor
SETH SILVERMAN

A chief target for all drilling department managers is trouble cost reduction. One class of lubricants, dubbed "physical" or "mechanical" lubricants, has significant promise as a replacement for conventional lubricants. The solid lubricant, called Thuslick, is a naturally occurring plumbago particle coated with silicon using a patented process. This material squeezes into pores and surfaces to form a flexible film that withstands tremendous heat and pressure and will not break down. Such a material is available as a solution to reduce trouble costs related to high torque and drag. The silicon-encapsulated graphitic material has been particularly helpful for drilling extended-reach or directional wells. The primary impact is to optimize lubrication, particularly at elevated temperature. Secondary effects are to inhibit hydration of the clay fraction in shale and claystone and reduce wellbore damage, especially vibration-induced formation damage, which results from stick slip events.

The plumbago particles are modified with a proprietary process that encapsulates the graphitic particles with a hydrophobic silicon coating. The particles (22-micron median size) are inert and insoluble in oil and mud, and are compatible with anionic, nonionic and cationic polymers, polyethylene and polypropylene glycols, oil-based fluids and brines. The material exhibits stability up to 931°F (500°C).

Enhanced mud properties

Once dispersed in a mud system, Thuslick particles produce greatly reduced surface tension between the predominantly water-wet surfaces downhole. The microparticles physically impregnate and coat the wellbore, forming a thin and extremely slippery surface. In turn, the filter cake creates an environment of reduced water absorption by clay-bearing formations (where permeability exists). The particles consequently coat the drilled clay solids, which prevents swelling.

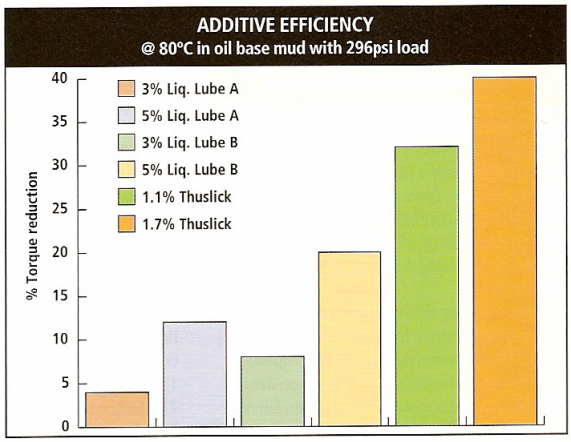


Figure 1. The torque reduction achieved by the Thuslick additive in oil-based mud is significant.

Field results verify torque and drag are reduced, which leads to better transmission of weight to the bit, thus improved penetration rates. Laboratory data shows the effectiveness of the Thuslick material in oil-based mud and reveals lubricity effects at different temperatures for several mud systems (Figures 1 and 2). Tripping, logging and casing run times have been improved. The filter cake reduces stick slip, which allows more constant bit revolutions per minute and longer runs. The Thuslick material is considered a medium- to low-pressure lubricant that does not reduce cutter efficiency. The field results demonstrate better gauge holes result, and less mud volume is required to drill a section.

The use of Thuslick has resulted in drilling fluid cost savings by reducing the consumption of filtrate control agents as much as 50%. Thuslick has an adhesive property that is environmentally safe and nondamaging to the formation; it subsequently coats and smears the entire surface of the borehole and all tubulars as well as establishes a presence throughout the filter cake. This optimizes the downhole frictional forces between the borehole and filter cake and the drill pipe and bottomhole assembly (BHA). This novel material has been shown in lab tests and field trials to reduce ☛

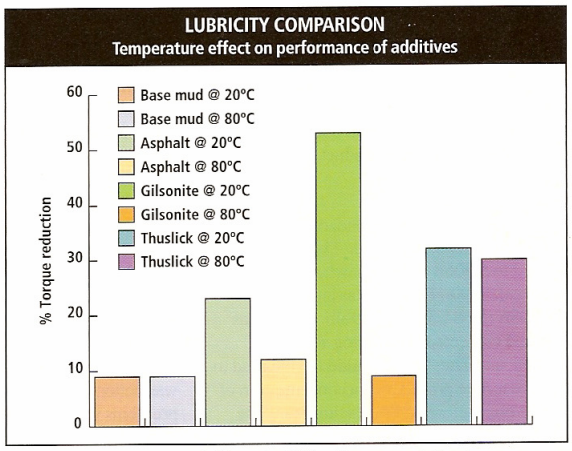


Figure 2. Lubricity for several different additives is compared at various temperatures.

Resultados

TABLE 1. SOLID LUBRICANTS MAKE THE TRIP EASY

- Improves trip, logging and casing run time
- Eliminates or significantly reduces:
  - Damage to brittle formations from string whiplash
  - Torque and drag values
  - Bit and bottomhole assembly balling
  - Tubular and drilling equipment wear
- Provides:
  - Water-repellent film coating of shales and claystones
  - Physical retardation of clay swelling
  - Stabilization of troublesome formations

the surface tension of oil, therefore enabling PDC bits to be used in water-based mud. Due to the hydrophobic properties of the outer silicon coating, formations that hydrate readily can be drilled in water-based mud without the fear of bit or BHA ball-up. Due to a reduction in hole drag, the desired weight on bit is attained.

Return permeability testing at Westport Technology Center International has shown Thuslick is nondamaging to the completion zones. The water-repellent characteristics of the silicon coating ensure maximum filter cake "liftoff." Testing is about to begin to address a completion zone filter cake containing Thuslick and calcium carbonate. This work will determine if a more efficient filter cake can be formed using the two materials synergistically. Return permeability tests already have confirmed Thuslick exits the formation readily once underbalanced conditions are achieved in the wellbore (i.e., production begins). The material exhibits some flexibility that allows it to deform to fracture size. Several major operators have expressed interest in using this material for completion brine applications.

Numerous indirect benefits are listed in Table 1. The Dutch Ministry of Mines, Norwegian State Pollution Control Body and the UK Department of Ecology have approved the nontoxic, nonhazardous material for use offshore. In the Gulf of Mexico, Thuslick has passed LC/50, 96-hour testing and static sheen tests, which obtained 1,000 ppm soluble petroleum product.

Record bit run

An operator drilled an extended-reach well in Tierra del Fuego, Argentina. The well was drilled to 5,906ft (1,801m), where the curve was built to 90°. Drilling continued to 18,308ft (5,584m), where 9⅝in. casing was run and cemented. The casing shoe was drilled, and Thuslick was added to the mud to relieve torque problems at a concentration of 4.8 lb/bbl. Before adding the lubricant, the sliding rate was between 16ft/hr and 33ft/hr. After the lubricant addition, the sliding rate increased to between 59ft/hr and 66ft/hr with a bit weight of 5,000 to 18,000lb. Rotary drilling resumed with Thuslick increased to 5.5 ppb. Drilling rates of 217ft/fr were obtained with a torque of 25,000 to 28,000 ft-lb. The well was drilled a 21,162ft (6,454m) TD with a final well angle of 91°.

Additive synergy

Occidental's Venezuela subsidiary drilled part of the **Alturitas-41** well in July 1996 using Thuslick at a measured depth of 10,360ft (3,160m). Two days prior to adding the material, slide drilling was taking place, and the average rate of production was between 7ft/hr and 12ft/hr. Torque had been high with the motor stalling out occasionally. Numerous tight spots were encountered below 9,700ft, and shale carvings were found in returns while circulating bottoms up. Thuslick was added at 5 ppb. A trip made a day after the addition of Thuslick from 10,413ft (3,176m) had no excessive overpull. On the trip back in, the last stand was washed and reamed to bottom with no fill. Drilling over the next couple of days averaged between 9ft/hr and 12ft/hr with bits pulled that were out of gauge. The hole consequently had to be reamed. Baranex was added at 4 ppb to aid in fluid loss. During the next 2 weeks, the flow properties did not change to any great degree. The angle was built to 59.9°, and there seemed to be a slight dogleg near the bottom of the hole. However, the well was drilled to total depth with little time lost due to hole problems, except for the reaming associated with out-of-gauge bits. There was 10,000ft (3,050m) of open hole when total depth was reached. The operator saved an intermediate casing string.

Reduced drilling time

Problems of drag, high torque, bit balling and low production rates were experienced in the intermediate hole (12¼in.) in the **Ceuta** field at **Block-VII**, Area 8. To eliminate the use of mineral oils due to environmental concerns, Thuslick was used in the intermediate 12¼in. holes of four wells (**VLG-3854**, **VLG-3857**, **VLG-3860** and **VLG-3861**) at a concentration of 4 ppb. Petroleos de Venezuela SA (PDVSA) discovered that in the hole's 12¼in. intermediate phase, drilling time was optimized from 23 days to 16 days. The time for every 1,000ft (305m) drilled went from 2.2 days for the VLG-3854 well to 1.5 days for the VLG-3861 well. The rate of production increased from 29.1ft/hr in the VGL-3854 well to 34ft/hr in the VGL-3861 well. Drag was reduced, and the hole stability was better. The time lost for mud or hole problems was reduced from 1.4 days on the VLG-3854 to zero days on the VLG-3861. The investment in Thuslick represented about 8% to 10% of the fluid cost in the intermediate hole. The benefits observed more than offset the material cost. The addition of Thuslick made a significant improvement to the drilling program in combination with the other additives (Ven Lube, Lube 100 and cellulose fibers MIXII F/M).

TABLE 2. RECOMMENDED TREATMENT

Mud Density, ppg	Thuslick concentration, ppb
10	3 - 4
7	4
5	5
5	6
16	7
18	8

Torque control

Amoco Trinidad Oil Co. used the Thuslick additive in a freshwater poly-anionic cellulose mud containing a substantial level of lost-circulation material on a horizontal well, **Samaan C5XX**. The system was used to drill an 8½in. hole from the kickoff point at 6,100ft (1,861m) MD, and building angle to 90° at the rate of 8°/100ft from 7,600 to 8,900ft (2,318 to 2,715m). At 8,372ft (2,553m), the torque increased to 680 amp, which caused sliding problems. Treatment of the active mud system with 4 ppb Thuslick reduced the torque to 450 amp. At 8,800ft (2,684m) the angle reached 89°, and lateral drilling began. The angle continued to increase, reaching 90° to 93.7° at 9,393ft (2,865m). The decision was made to reduce angle and increase true vertical depth, but proved difficult due to erratic torque, which exceeded 600 amp. Thuslick concentration was increased to 5 ppb. A torque reduction to 500 amp was observed.

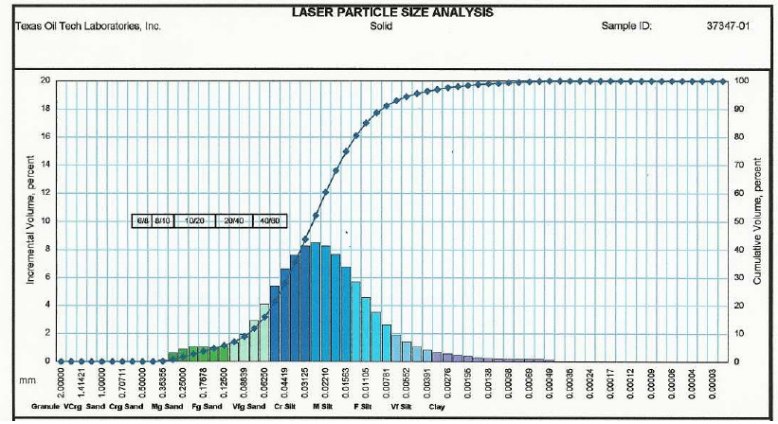
Slug treatments of the lubricant also were found helpful in this well. While slick rotary drilling at 8,820ft (2,690m), erratic torque (450 to 650 amp) was brought under control (450 amp) to permit sliding. While back-reaming out of a tight spot on the well at 8,447ft (2,576m), slug treating with Thuslick brought the torque down from 650 to 550 amp. Beyond 9,500ft (2,898m) erratic torque of 600 to 800 amp was observed and reduced to 530amp with a high-concentration Thuslick pill.

Economics of use

The use of the solid lubricant is justified based on numerous operating factors that include time savings through extended bit life and improved rates of production. The initial treatment rate is comparable to other liquid lubricants. However, significant advantages have been observed in the field in the system maintenance arena, including dilution minimization, seepage losses, water-loss additive savings and most importantly, a reduced number of days on the job. ■

Particle Micronization Chart & Field Application

THUSLICK™



Fine Micronization using Patented Process

Successfully used on multiple wells