North Sea: SILDRIL™ Gives Top Performance in High-Angle Well

"The operator was faced with drilling a 12¼-in. hole through reactive Tertiary shales and unconsolidated sands from vertical to 85° at 5°/100 ft, targeting a narrow horizontal sand reservoir. The use of a SILDRIL KCl silicate water-base mud yielded the required inhibition and added a degree of cohesive strength to the sands that resulted in complete success. This was the first time SILDRIL had been used to drill at a very high angle, but we had confidence in the system and that the technology would achieve success."

Well information

Location:	Central North Sea
Spud/completion:	June/October 1998
Interval drilled:	12 ¼-in. hole for a total of 2,613 ft – from 1,490 to 4,103 ft
Deviation:	Vertical to 85°

The situation

After setting 13 3/8-in. casing at 1,490 ft, the operator wanted to drill directionally to 85° in preparation for drilling horizontally into a narrow sand reservoir. The target was crucial, as the operator wanted to install a submersible pump and run a pre-packed screen completion. There was no room for error.

The formation to be drilled was highly reactive Tertiary shales interbedded with unconsolidated sands. Drilling this interval successfully would require a high degree of inhibition and optimal hole cleaning. The correct rheology profile was required to avoid washing out the unconsolidated sands at angles around 60°.

The solution

On the basis of tests performed in Aberdeen and extensive computer modelling based on offset data, a SILDRIL water-base mud, containing 5.0 % by volume sodium silicate, was recommended as the optimum system. It was to be first time the SILDRIL system would be used to drill to such a high-angle well.

The results

- Fast drilling. The interval was drilled and cased off in five days.
- All targets met. All targets were achieved as the reservoir was drilled as planned through 2,500 ft of sand. The completion was run and the well tested successfully.
- Excellent lubricity. Additions of 2.5% and 3.5% volume of silicate lubricant (EBL) additive reduced the average coefficient of friction from 0.39 to 0.25.

SILDRIL benefits:

- High ROPs
- Met all objectives
- Excellent lubricity
- Reduced costs

The details

SILDRIL water-base mud was used to provide maximum inhibition while drilling the 12¼-in. hole section through the claystone.

An initial load-out of 1,250 bbl of concentrated KCl containing 11.0% by volume SILDRIL, was delivered to the rig at the end of the previous interval. An additional 711 bbl of KCl brine was delivered to the rig while drilling this section.

While kicking off, part of the cement plug was drilled with mud from the previous section to avoid silica depletion from cement contamination. Since the reaction between silica and calcium (from cement) is almost instantaneous, and the reaction between calcium and carbonate is comparatively slow, pre-treatment for calcium with sodium bicarbonate or soda ash would not have been beneficial. Once the cuttings were confirmed as 100% formation, the hole was displaced to the KCl/SILDRIL mud.

The mud density was kept to a minimum throughout the section. The fluid at the start of the section yielded initial minimum weights of 9.45 lb/gal, increasing to 9.7 lb/gal.

The mud used for the initial active system was diluted with drill water and caustic soda to give 7.5% by volume SILDRIL. This level dropped to 4.5% after the displacement. The level of SILDRIL was then maintained at 4.5 - 5% through the claystone. This was achieved through the addition of SILDRIL in IBC Containers (m^3) and the addition of premixed silicate mud with a silicate concentration of 7.5%.

Hole cleaning in this section was good while rotating, but as a high percentage of drilling was in sliding mode (60-80%), fine solids/cuttings dropped to the low side of the annulus as the angle reached 86°. On the first trip from 3,408 ft, most of the cuttings were circulated out while back-reaming out of the hole. The remainder were removed during the wiper trip prior to coming out of the hole to run casing. When circulating the casing prior to the cement job, the hole was displaced with new lower-rheology 10 lb/gal mud.

Properties of SILDRIL while drilling the interval.

Mud Properties	Programmed	Minimum	Maximum	Typical
Mud Weight, lb/gal	9.5 - 10.0	9.5	10.0	9.6
Plastic Viscosity, cp	-	9	18	14
Yield Point, lb/100 ft^2	25 - 30	21	38	29
6 RPM (120°F), 1b/100 ft^2	12 - 15	8	16	12
Gel Strengths, 10"/10', lb/100 ft^2	14 – 18 / 20 - 25	8/12	13/18	9/13
API Filtrate, cm^3	8-6	4.2	5.2	4.2
MBT, lb/bbl	20 Max	5	25	20
pH	11.5 - 12.5	11.4	11.5	11.4
Total Hardness, mg/L	-	0	0	0
Chlorides, mg/L	-	47,000	55,000	53,000
KCl, lb/bbl	30 - 35	25	30	30
LG Solids, % by volume	-	1.6	10	5.7
SILDRIL, % by volume	3 - 5	4.9	5.7	5.3

Questions? We'll be glad to answer them.

If you'd like to know more about SILDRIL and how it's performing for our other customers, please call the M-I office nearest you.

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