CASE STUDY

Norway: MD-3 shakers enable LCM recovery to maintain high concentrations while drilling with solids control

Well Information

Location ..... Norway, North Sea

Total Well Depth ..... 12,794 ft (3900 m) MD/10536 ft (3211 m) TVD

Section ..... 8 ½ in. - reservoir

Section Interval ..... 10,794 ft – 12,794 ft MD (3,290 – 3,900 m)

Drilling Fluid ..... VersaTec OBM @ 10.2 – 12.0 lb/gal (1.22 – 1.44 sg)

Estimated Reservoir Temperature ..... 2,200° F (1,040° C) 6,169 ft (1,880 m) MD

The Situation

This 8 ½ in. section had been previously drilled and plugged back by another rig due to serious formation mud loss. Geotap pressure points had indicated pressures as low as 7.2 ppg (0.87 sg) in the upper section of the reservoir, while the pore pressures in the deeper formation were expected to be in excess of 11.0 ppg (1.32 sg). Drilling both formations as one section would mean differential pressure across the interval in excess of 2,000 psi, significantly higher than the historical fracture mud weights of 11.0 ppg (1.32 sg). However, the cost savings would be considerable if it was possible.

In order to increase the near borehole fracture strength, the interval would be drilled with a VersaTec* oil-base mud (OBM) system carrying a relatively high concentration of lost circulation material (LCM) with a broad range of particle sizes. As the bit passed the lowest recorded pressure point, the density of the drilling fluid would be gradually increased from 10.2 ppg (1.22 sg) to between 11.0 (1.32 sg) and 11.5 ppg (1.38 sg). Any induced fractures would be plugged as they formed and the fluctuating ECD with pumps on and off would result in the fractures closing up on the trapped particles and increasing the formation density and strength in the proximity of the well bore.

When drilling with high LCM concentrations, the previous strategy has been to remove the lower screens and use only a coarse scalping screen to remove the largest drill solids. The problem with this practice is that the significant quantities of drill solids in the mud system had a detrimental impact on the drilling mud properties, such as increased weight, viscosity and fluid loss. If the shale shakers are dressed “normally” to screen out the drill solids, the potential LCM consumption is not manageable. As an example, trying to maintain 40 ppb (115 kg/m^3) at a circulation rate of 450 gpm (1,703 lpm) if screening out 75% of the LCM requires addition of nearly 9 mt/hr.

The Solution

Three triple deck MD-3* shale shakers were installed with the LCM recovery equipment option. As part of the shaker installation, an extra cuttings trough and mud recirculation system would enable the screening out and return to the drilling mud of a specific particle size range. If this returned particle size can cover the majority of the LCM material, then it can be recovered to the mud system while screening out the coarse drill solids that are discharged off the top screen. LCM is recovered from the middle screens and the fine drill solids are removed with the lower screen. In theory, then, the LCM additions required are only to maintain the concentration in any maintenance mud volume and to replace the finest degraded particles.

The LCM material used was a 50/50 mix of Torque Seal* ground walnut shells and G-Seal* graphite. G-Seal graphite has been used regularly in this area as a loss prevention and shale stabilization material. Torque Seal ground walnut shells were chosen to replace previously used coarse calcium carbonate type material, as it retains its particle size more effectively and has a specific gravity of +/- 1.2 sg so avoiding problems of settling in the hole or pits. Theoretically, these two components gave a particle size distribution of 200 micron to 2,000 micron.

The Details

Prior to drilling a 10.2 ppg (1.22 sg), the VersaTec mud system was prepared on shore containing 20 ppb (57 kg/m³) Torque Seal ground walnut shells and 20 ppb (57 kg/m³) G-Seal graphite. The well was displaced after drilling out the casing shoe to this mud. By using frequent sieve analysis the concentration of LCM was maintained between 25 ppb (71 kg/m³) and 35 ppb (100 kg/m³) for most of the section. During the drilling of this section, the mud densities required to control wellbore pressures exceeded the program expectations; eventually reaching 12.0 ppg (1.44 sg) (resulting in an ECD approaching 12.5 ppg (1.50 sg)). At this point significant losses were experienced and this, combined with a water-wet formation resulted in the bottom of the hole being plugged and only the upper reservoir being completed.

Summary

The use of the MD-3 triple deck shakers in LCM recovery mode enabled the Ekofisk section to be drilled with mud weights as high as 12.0 ppg (1.44 sg) compared with a pore pressure equivalent of 7.2 ppg (0.86 sg). This was significantly higher than in the previous well where circulation had been lost once the mud weight reached 10.5 ppg (1.26 sg).

This was the first time the MD-3 shakers had been used in an offshore location for LCM recovery. Challenges encountered, related to matching the larger particle size of the LCM material to the cut point of top deck screens. This can be remedied by a larger selection of course mesh screens and quality assurance (QA) of the LCM material. The shale shakers and the recovery system worked, with limited plugging of equipment and a greatly reduced LCM usage.

Experience from this section has shown that with correctly sized shaker screens a significant amount of the loss prevention material can be recycled, which enables high concentrations to be maintained and a well bore strengthening effect to be achieved. In this case an overbalance of nearly 2,400 psi (165 bar) was achieved without loss, this was nearly 900 psi (62 bar) over the expected fracture pressure in this reservoir.

Questions? We'll be glad to answer them.

If you'd like to know more about well bore strengthening, our loss circulation materials and the application strategies that are performing for our customers, please call the M-I SWACO office nearest you.

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