Case History
Baroid Industrial Drilling Products

Successful Use of PETROFREE® System in the Dallol Depression

Location: Dallol, Ethiopia

Illustration 1 Cores drilled with salt muds

Illustration 2 Formation lithology

Illustration 3 Mixing PETROFREE® system

Customer Challenge

Sainik Potash, an Indian company, approached Baroid IDP to explore options for improving core recovery on their Dallol, Ethiopia potash lease. The scope of the project is three fold:

- Explore and delineate their lease in the Dallol Depression.
- Determine compressive strength of the Bischofitite (Magnesium Chloride) overlaying the Potash bearing formations.
- Produce Potash from the Silvinite and Kainitite formations using subsurface solution mining and surface evaporative techniques.

Obtaining full diameter 10cm cores in Bischofitite and Carnallitite formations for rock mechanic studies became a primary objective as they neared the production drilling phase. This had never been achieved with their salt saturated systems.

The Dallol Depression is an evaporative basin formed by an ancient sea and has an average elevation of 120 m below sea level. The lithology from surface is predominantly evaporites, primarily Sodium Chloride, hence is highly soluble and difficult to drill with Water Based Muds. A lithological sequence was provided (Illustration 2) to give an idea of the extremely water sensitive conditions in these holes, virtually from top to bottom.

Baroid IDP Engineered Solution

The PETROFREE® Oil Based Mud System had been successfully employed in Botswana for DeBeers (Debswana) and we were confident that this was the only way that full diameter core recovery was possible in these highly water sensitive formations. The Customer had hole problems using saturated salt systems (Sodium chloride and Tri-Salt) including stuck pipe, average core recovery and poor casing cement jobs so they were willing to try the PETROFREE system suggested by IDP.

Lab formulated PETROFREE® System
2% Water by volume
❶ 0.96 bbl (163 liters) DRIL-N-SLIDE™ Base Oil
❷ 2.25 lb/bbl EZ-CORE™ Emulsifier
❸ 10 lb/bbl GELTONE® II Viscosifier

Initial fluid properties on site were:	
Depth	252.6m
Oil-to-Water Ratio (OWR)	98/2
Marsh Funnel Viscosity	40 sec/qt
Fluid Density	0.88 g/cm³
Yield Point (YP)	2 lb/100 ft²
Plastic Viscosity (PV)	12 lb/100 ft²
10 sec/10 min Gel Strengths	4/6 lb/100 ft²

Final fluid properties on Day 6 were:

Depth	286.4m
Oil-to-Water Ratio (OWR)	85/15
Marsh Funnel Viscosity	50 sec/qt
Fluid Density	1.1 g/cm^3
Yield Point (YP)	8 lb/100 ft^2
Plastic Viscosity (PV)	28 lb/100 ft^2
10 sec/10 min Gel Strengths	6/9 lb/100 ft^2

Fluid Properties

Soon after commencing drilling with the PETROFREE® system some naturally occurring oil with water was encountered. The incorporation of this formation fluid weakened the emulsion so the fluid was dumped and fresh base oil and E-Z CORE™ emulsifier were added to correct the mud properties. Shortly after this, at approximately 276 meters, a steady backflow was experienced whenever the mud pump was switched off. The ingressed fluid was dumped at the surface and the mud constantly treated with EZ-CORE, GELTONE® II and BAROID® barite. Upon testing the fluid intrusion, it was clearly seen to be a salt saturated polymer mud used to drill the previous sections behind the casing. This confirmed Sainik's suspicion that the casing cement job was very poor. Unfortunately, as the rig was unable to pump and mix mud simultaneously, maintaining the mud properties was very difficult and for practicality and economy, the OWR was allowed to drift to 85/15. This also made it easier to maintain the Yield Point above 8 to suspend the barite. Density was increased to 1.1sg while drilling.

After completing this hole the rig was adapted so that it could mix and core simultaneously using an external pump and modifying the venturi mixer. There was no provision for shear mixing or solids control at this site except for tank settling. Baroid IDP designed a small hopper to work off the rig mud pump and a four compartment settling tank which were fabricated on-site.

Drilling rate, core recovery and core quality were all improved over the salt muds, but the low density of PETROFREE® made it vulnerable to salt water and salt mud invasion. Despite the relaxation of the OWR, core recovery was 100% with very little core erosion or loss.

The mud was conditioned for storage and decanted into 55-gal drums for use on the next hole. Detailed instructions and training were given to the drillers and on-site geologists as to a treatment and maintenance program to commence after displacement of the salt mud.

Illustration 4 Cores drilled with PETROFREE® System

Economic Value Created for Customer

Obtaining full diameter cores were critical to proceeding to production drilling, hence the economic value was huge. Furthermore, using PETROFREE® would reduce in-hole rod losses, wear and tear on pumps and rotating equipment and provide them with gauge hole to improve production casing cementations. The difference is dramatic and the cores drilled with PETROFREE® (Illustration 4) were the only cores taken to date that were most suitable for rock mechanic studies.

BAROID Industrial Drilling Products

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