Case History

CleanDrill™ High-Performance Water-Based Drilling Fluid Successfully Drills Challenging Horizontal Extended Well, Onshore Bahrain

CleanDrill™ high-performance water-based drilling fluid (HPWBM), with KCl brine and customized bridging/sealing materials, enabled an operator in Bahrain to drill a horizontal gas well targeting a deeper horizontal section reaching total depth ahead of plan with minimum damage to the reservoir

CHALLENGE	SOLUTION	RESULT
• Horizontal gas well targeting deeper section of reservoir • Drill & complete challenging horizontal openhole interval using HPWBM • Anticipated high BHT up to 300°F • Narrow drilling window and low fluid density of 8.8 – 9.2 lb/gal • Minimize risk of formation losses, excessive torque and differential sticking	• Use CleanDrill™ system with KCl as brine base to minimize formation damage • Provide proper rheology for excellent cuttings transport efficiency • Use amine-based inhibitor to control reactive clays • Formulate with a package of bridging and sealing material	• Successfully drilled extended-reach horizontal open-hole interval • Maintained superior filtercake quality while drilling interval • No occurrence of excessive torque and drag • 4.5-in. liner lowered smoothly • Excellent wellbore stability • Completed well 10 days ahead of the planned schedule

OVERVIEW

The Newpark inhouse team for a key operator in Bahrain was challenged to design and execute an integrated fluid system approach with the use of a high-performance water-based drilling fluid (HPWBM) to drill the reservoir section and complete a deeper challenging horizontal open-hole interval, with high tendencies of formation losses.

The goal was to design a HPWBM to provide an efficient bridging capacity, enhance wellbore stability, provide sufficient inhibition and lubricity while drilling the extended horizontal section.

The answer came in the form of a specialized KCl brine-based CleanDrill™ high-performance water-based drilling fluid system with a maximum fluid density of 9.2 lb/gal to drill the open horizontal section in an area characterized by inconsistent formation pressures and highly reactive, stressed interbedded shale and sandstone sections. In addition, all fluids were planned to be built on location, requiring exceptional logistical management and pre-well planning.

CHALLENGE

Newpark's specialists established the following benchmarks for the design of an applicable technical and cost-effective fluid solution:

- Extend the temperature limit for the polymers due the high bottomhole temperature exceeding 250°F.
- Achieve superior fluid loss control while drilling. The 200 to 600 mD reservoir permeability would require bridging to avoid seepage losses and formation damage.
- Strengthen the formation with proper bridging and wellbore strengthening material. Optimize the bridging materials package for plugging microfractures and bridging the formation via the

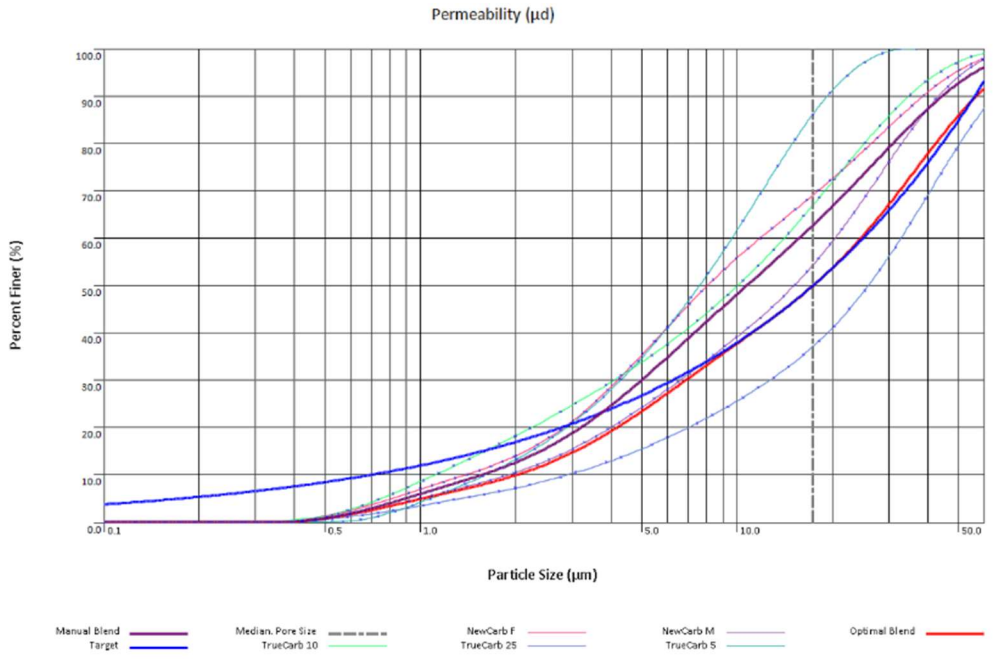
Newpark proprietary software ClearTrack™

- Formulate a HPWBM using KCl brine, acid-soluble solids with a concentration range of 20 to 25 lb/bbl to achieve final fluid density of 8.9 to 9.2 lb/gal.
- Provide lubricity to minimize torque and drag.
- Build the fluids formulations on location.

Following extensive lab testing, the operator and Newpark fluid specialists selected the KCl CleanDrill system for drilling the reservoir section. Performance of the CleanDrill was carefully pilot tested to achieve optimal field execution. The test data confirmed the selection of the following Newpark Fluids System and products:

- CleanDrill HPWBM utilizing potassium chloride brine as the base fluid
- NewPerm NF™ proprietary shale inhibitor to control highly reactive clays
- GageTrol™ fluid loss control agent in combination with Victosal™ HT modified starches to ensure superior fluid loss control even when exposed to high temperature and pressure.
- Customized blend of TrueCarb™ metamorphic calcium carbonates for bridging and control losses through natural microfractures, optimise filter cake quality. Figure 1 shows the curves designed with ClearTrack™ bridging analysis software and the TrueCarb products used.
- NanoStable™ latex sealing agent for plugging shales and sealing low permeability sandstones to reduce pore pressure transmission and to strengthen the wellbore
- NewStabil thermal polymer extender was proposed as contingency product to improve together with Deoxy AB fluid stability after prolonged period of static ageing inside the hole.
- Solid lubricants to be added during drilling to minimize torque and drag comprising of NewSeal™ 25 sized graphite and Drill Beads – styrene plastic spherical beads

Figure 1: Outcome curve from ClearTrack™ bridging package design.



Laboratory testing was conducted to target the required fluid properties and confirm the bridging package capacity to strengthen the formation. The Permeability Plugging Tests (PPT) were performed using 20-micron ceramic disks.

Figure 2 below shows fluid formulation and test results. Formulation 7 was selected for this project.

Products Concentrations						
Clean Drill™ HPWBM	Pilot Tests Performed					
	Pilot 5		Pilot 6		Pilot 7	
SODIUM CARBONATE	0.50		0.50		0.50	
CAUSTIC SODA	0.15		0.15		0.15	
POTASSIUM CHLORIDE	12.00		12.00		12.00	
VISCO XC 84	1.00		0.75		1.00	
VICTOSAL HT	2.00		2.00		2.00	
GAGETROL	4.00		4.00		4.00	
TRUE-CARB 2	5.00		5.00		5.00	
TRUE-CARB 10	5.00		5.00		5.00	
INTASOL M	15.00		15.00		15.00	
INTASOL F	25.00		25.00		25.00	
AQUCAR GA 24	0.20		0.25		0.25	
NEWPERM NF	3.50		3.50		3.50	
NANOSTABLE	3.50		7.00		3.50	
NEWSEAL 25	-		-		4.00	
DEOXY AB	0.10		0.10		0.10	
NO FOAM X-EH	0.25		0.25		0.25	
Mud properties	P5		P6		P7	
Hot roll @ 250°F for 16 hours Rheology @120°F	BHR	AHR	BHR	AHR	BHR	AHR
MW , ppg	9.2	9.2	9.2	9.2	9.2	9.2
6 rpm	14	12	10	6	16	14
3 rpm	11	9	9	5	14	11
Plastic Viscosity, Cp	17	11	16	14	16	11
Yield Point, lb/100ft2	33	28	25	22	37	32
Gels 10 Sec, lb/100ft2	11	9	8	4	12	10
Gels 10 Min, lb/100ft2	12	9	8	5	12	11
API FL , ml	5.0	4.8	5.0	4.6	5.0	4.8
HTHP @ 225°F	13.2	13.6	12	12.4	12.8	13
PPT (1500 psi/ 250°F/ 20 microns), mL		19.2		12.4		13.2
PSD Test, D50, µ		54.90		54.42		58.16
Observation / Comments		No settling		No settling		No settling

Figure 2: Fluid formulation and results on the left; PPT filtercake on the right.

RESULTS

Use of KCl brine-based CleanDrill high-performance water-based drilling fluid helped to achieve operational objectives in a safe manner ensured the operator reached the well TD by providing adequate wellbore stability while avoiding excessive torque and differential sticking. Seepage dynamic losses were controlled to a rate of 40 to 80 bbl/hr using TrueCarb series bridging materials, NanoStable reduced the pore pressure transmission, preventing the occurrence of differential sticking and wellbore instability.

Overall Drilling performance was aided by good drilling practices including regularly scheduled short trips and tandem sweep regimens.

Drilling reached the planned TD at 17,550 ft. The project was executed and completed 10 days ahead of the plan and achieved the record for horizontal extended reach in the Bahrain field. A total of 5,675 ft was drilled in the final section (6⅛-in.) with a 4,300-ft horizontal interval. Required trips, logging, and RIH liner were performed with no issues.

Table 1 - Results using CleanDrill HPWBM					
Interval (ft)	Hole Size (in.)	Hole Angle (°)	Liner (size and depth)	Fluid Density (lb/gal)	Drilling Time (hr)
10,117 – 11,875	8⅜	47	7-in. @ 11,873 ft	8.8	78
11,875 – 17,550	6⅛	88	4½-in. @17,540 ft	9.2	319.5