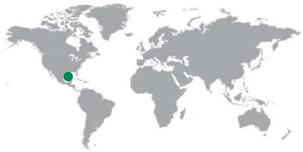
Case History



True™ Series Displacement Chemicals Effectively Clean Riser During Ultra-Deepwater Horizontal OHGP Completion, Gulf of Mexico

True™ Series Displacement Chemicals Offer Effective Mud Removal While Water-Wetting Tubulars in Ultra-Deepwater Horizontal Open-Hole Gravel Pack Completion

CHALLENGE	SOLUTION	RESULT
• Perform HPWBM direct displacement • Perform direct displacement of CleanDrill™ • Minimize post-displacement fluid system clean-up	• Engineered True™ Series displacement chemical spacer train • ClearDepth™ displacement hydraulic modeling • Systematic WBCU filtration process	• Effectively & safely displaced wellbore multiple times • Water-wet tubulars • Achieved or exceeded fluid cleanliness performance specifications

GOM Deepwater

OVERVIEW

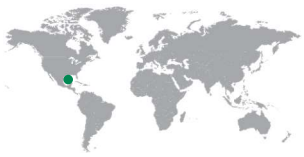
In the Gulf of Mexico deepwater market, operators with horizontal open hole gravel pack completions routinely utilize multiple types of fluids systems throughout the drilling and completion phases. These systems require seamless displacement or transition from one to the other through specifically designed procedures. Extreme water depths require large and longer marine risers making it problematic when cleaning up the wellbore and riser sections in a timely manner. A direct displacement is favored in order to accomplish the objectives of minimizing the volume and number of spacers pumped, maintaining hydrostatic control, and reducing rig circulating time. The selected rigs for these operations are ultra-deepwater, dual-activity drillships.

CHALLENGE

A major operator in the Gulf of Mexico required a solution to complete an 87° horizontal well while utilizing Controlled Mud Level (CML) managed pressure for an Ultra-Deepwater application at a depth of 8,166'. This project represents the first use of CML to complete a well in the GOM. The operation included a solution to drill surface hole with spud mud, drill the intermediate hole sections with a High-Performance WBM (HPWBM), drill the reservoir section with a formation friendly water-based RDF, and complete the well with reservoir compatible completion brine. The proposed sequence involved a direct displacement of 9.1 lb/gal NFS-100 HPWBM to a 9.1 lb/gal CleanDrill™ water-based RDF and later to a 9.2 lb/gal KCl completion brine. This was a horizontal open-hole, gravel-pack completion with production casing to greater than 10,000' MD (3,048 meters) open hole to greater than 13,000' MD (3,962 meters). The operator set completion fluid cleanliness specifications for the displacement to completion brine at <30 NTUs out of the well and solids content at <0.05%.

Newpark utilized lab tested chemistry and formulated the specific displacement chemical spacer train that transitioned from the HPWBM drilling fluid from the water-based RDF, provided water-wetting to the tubulars, and then from the RDF to the completion fluid. The displacement hydraulics were modeled with ClearDepth™ that optimized the pump rates, annular velocities, and spacer contact times for each displacement sequence. Pro-T filtration equipment was incorporated that allowed for the completion brine pump rates to be maintained for fluid cleanliness specifications.

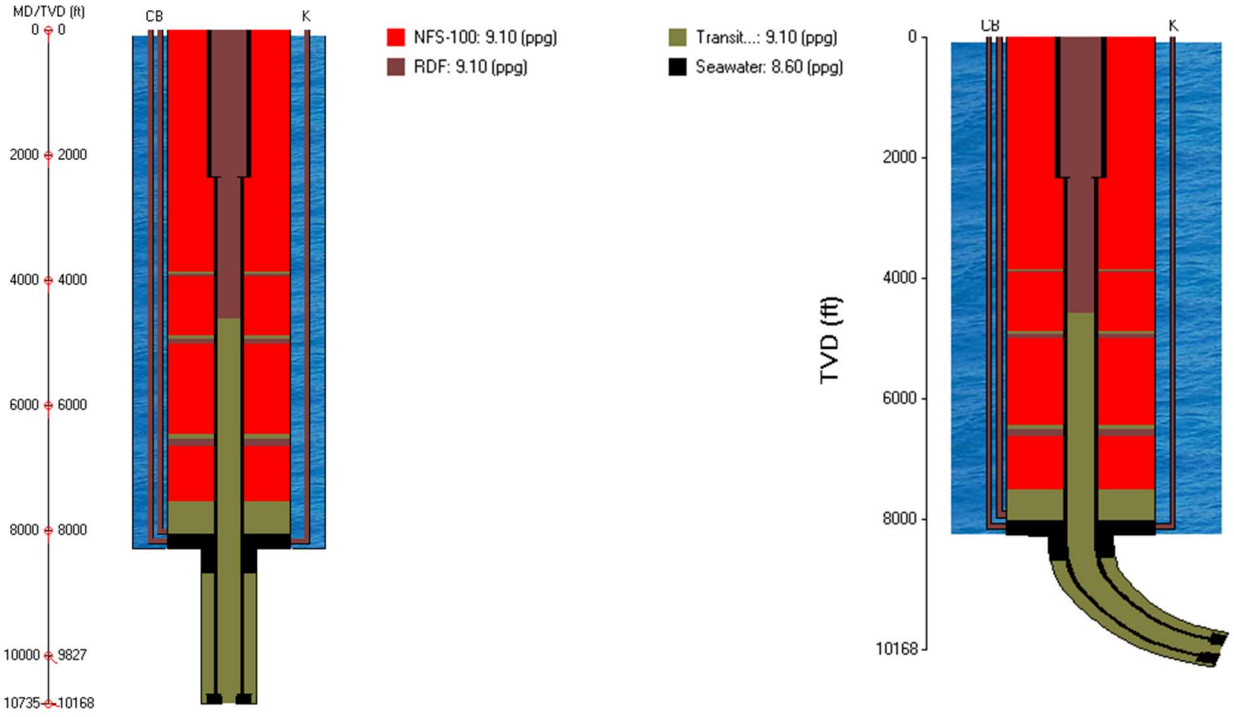
NEWPARK FLUIDS SYSTEMS

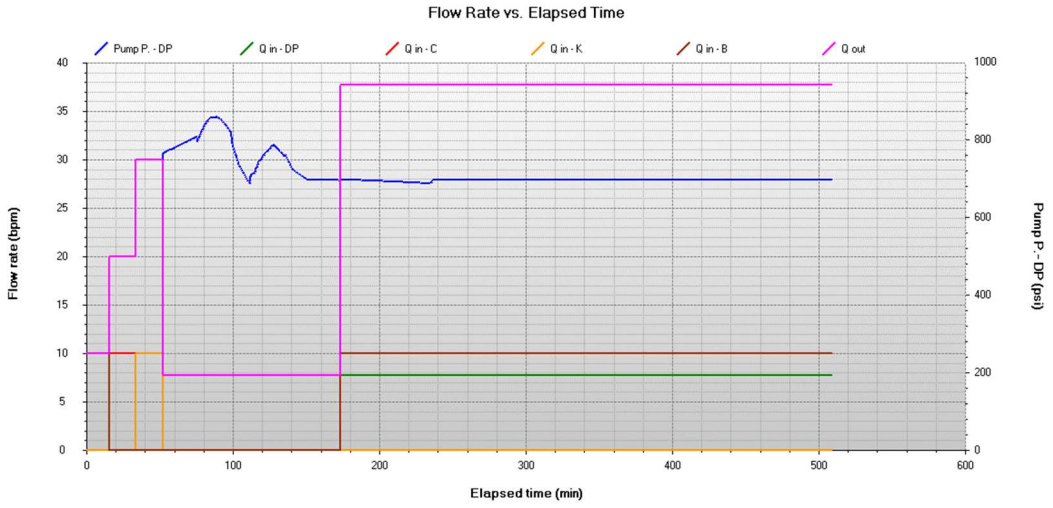


SOLUTION

Due to the compatibility of the HPWBM and the CleanDrill water-based RDF the majority of the rig cleaning process was completely eliminated. Likewise, the difficulty of displacement spacer formulations was removed. This allowed for an overall reduction in the number of spacers and total volume necessary.

Spacer	Type	Description	Products	Density	Volume
1	Transition	Weighted viscosified	CleanDrill™ RDF [XCD]	9.1 lb/gal	180 bbls
2	Thinning	Unweighted cleaning	Seawater	8.6 lb/gal	100 bbls
3	Transition	Weighted viscosified	CleanDrill™ RDF [XCD]	9.1 lb/gal	180 bbls





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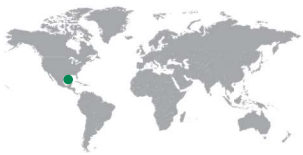
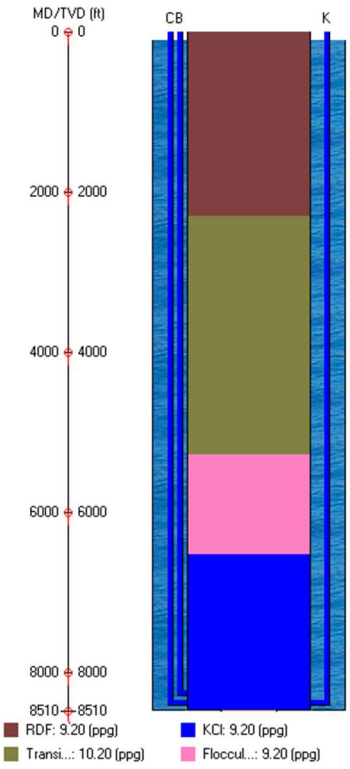


The spacers were pumped down the workstring at a target rate of 7.7 bpm due to BHA restrictions. The displacement spacer train was followed by CleanDrill™ RDF and continued until the water-based RDF was observed at surface without issue. The open-hole section was then drilled to TD.

The displacement from CleanDrill™ to completion brine followed a similar procedure. The rig surface fluid handling system was thoroughly cleaned of residual water-based RDF in preparation to receive completion brine. A True Series spacer train was formulated with TrueClean™ solvent/surfactant utilized in the transition spacer. This concentration was customized to the specific water-based RDF being displaced. Newpark was again able to reduce the number of spacers and total volume necessary.

Spacer	Type	Description	True™ Series Products	Density	Volume
1	Transition	Weighted viscosified	TrueZan L™ RDF [XCD], TrueClean™ [solvent/surfactant]	9.1 lb/gal	359 bbls
2	Flocculant	Weighted	TrueFloc™	9.2 lb/gal	150 bbls



Time (min)	Fluid (in/Btm/out)	Q in - DP (bpm)	Q in - C (bpm)	Q in - K (bpm)	Q in - B (bpm)	Vol. in - tot. (bbl)	ECD @ 8510.0 (ppg)
0.22	7/6/6	-	10.00	0.00	0.00	2.185	9.27
16.80	7/6/6	-	10.00	0.00	0.00	168.000	9.27
33.60	7/6/6	-	0.00	10.00	0.00	336.000	9.27
33.82	3/6/6	-	0.00	0.00	10.00	338.185	9.27
69.72	8/6/6	-	0.00	0.00	10.00	697.185	9.50
84.72	7/6/6	-	0.00	0.00	10.00	847.185	9.64
97.80	7/6/6	-	0.00	0.00	10.00	978.000	9.63
136.12	7/6/3	-	15.00	0.00	15.00	2127.485	9.60
163.07	7/6/8	-	15.00	0.00	15.00	2936.058	9.20
174.29	7/6/7	-	15.00	0.00	15.00	3272.600	9.20
174.47	7/6/7	-	15.00	0.00	15.00	3278.000	9.20

The spacers were pumped down the kill line at a target rate of 10 bpm followed by the 9.2 ppg KCl completion brine. The boost line was engaged once the tail end of the displacement spacer train was greater than 100' above the boost line. It was at this point that a target rate of 15 bpm down the boost line while circulating KCl completion brine was achieved. The pumping of 9.2 lb/gal KCl completion brine continued past the point it was observed at surface until it reached cleanliness specifications, which was only an additional 30 minutes.

The workstring and drilling BHA tool assemblies were pulled out of the hole prior to the displacement. With the available pit space all required completion fluid was on surface and within fluid cleanliness specifications prior to the displacement to avoid the need to filter while displacing.

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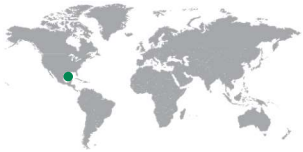

RESULTS

All spacers returned to surface when expected. The total displacement time was 7.75 hours. There was just a little over 1.5x well volumes circulated. The final fluid clarity endpoint result was 97 NTUs and <0.05% solids out of the well, which satisfied the specified target established by the operator. The use of specific chemistries coupled with reliable hydraulics modeling and proper filtration resulted in multiple successful displacements.