



Direct Water Injector Wells Successfully Completed on West Africa Deepwater Development

ORCA™ for WBM successfully deployed on ten Direct Water Injection wells as part of a major deepwater field development, offshore West Africa.

CHALLENGE	SOLUTION	RESULT
<ul style="list-style-type: none"> Matrix Water Injection required on 10 wells to support 11 oil production wells on major subsea field development Direct Injection wells – no flowback to clean up Water depth 700 – 1400m Two target reservoir sands Long horizontal sections – risk of heavy losses to formation post breaker placement 	<ul style="list-style-type: none"> Completed in 8 ½” hole using Wire Wrapped Sand Screens with ICD’s and Swell Packers Detailed design of filter cake breaker treatment through extensive laboratory testing Optimised ORCA for WBM filter cake treatment selected Reservoir Drilling Fluid managed to maintain non-acid soluble solid content < 1.0% 	<ul style="list-style-type: none"> Horizontal reservoir sections successfully drilled ORCA treatment applied on all 10 injector wells Target injectivity rates successfully achieved All well outcomes met campaign objectives

CHALLENGE

A deepwater subsea development off the coast of West Africa required 10 water injector wells to be drilled and completed to drive production to 11 nearby oil producers. As matrix injectivity was required and the wells could not be produced to clean up prior to initiating injection, the importance of removing all filter cake residues post-completion was essential. The 8 ½” reservoir sections were drilled between 85 and 93 degrees from 1000 to 1700 metres (3280 – 5578 ft.). The long, deviated sections required a breaker to be activated only after a time delay to ensure complete coverage of the open hole.

	<i>Upper Sand – Water Injector</i>	<i>Lower Sand – Water Injector</i>
<i>Depth (mTVD-RT)</i>	2,610 to 2660	
<i>Expected Rates (bbl/d)</i>	8,000 - 30,000	
<i>Formation Properties (Water Injection Wells)</i>	<i>Ave Permeability: 770 mD D₅₀ PSD: 30-130 micron</i>	<i>Ave Permeability: 104 mD D₅₀ PSD: 15-80 micron</i>
<i>Temperature</i>	67 to 85 °C	

Table 1 – Summary of Injector Well Properties

SOLUTION

An ORCA for WBM filter cake treatment formulation was developed and deployed on each of the injector wells.

A highly detailed workflow was implemented from design through to execution to ensure the success of the breaker treatment:



Pilot Laboratory Testing

Laboratory scale breaker efficiency testing was performed on ORCA formulations across the anticipated well temperatures and mud weights. Performance was evaluated in both production and injection directions.


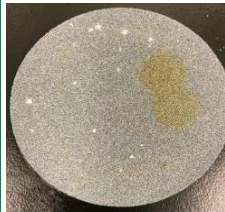
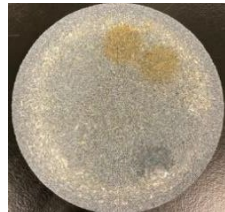

Breaker	1.18 s.g. Breaker Formulation 1	1.18 s.g. Breaker Formulation 2	1.29 s.g Breaker Formulation 1	1.29 s.g Breaker Formulation 2
Temperature, °F	135	135	190	190
Breaker Density, s.g.	1.18	1.18	1.29	1.29
Initial pH	4.59	4.51	4.53	4.37
Post Soak pH	3.3	2.85	3.55	2.99
Return to Flow Results (%)				
Production	98.62	100	100	100
Injection	98.35	96.13	99.13	96.57
Photos				

Table 2 – Screening Test results, ORCA Formulations

(note negative test for starch with iodine)

QA/QC Testing

Quality control testing was performed on the ORCA chemicals supplied for the project, from manufacture through to performance testing of the final filter cake treatment on a sample of field RDF prior to mixing and pumping.

The formulation was optimised and validated through extensive laboratory testing against the Reservoir Drilling Fluid formulation.

RDF Drilled Solids Content

Previous experience had identified that successful matrix injection is heavily influenced by the concentration of acid insoluble solids (AIS) present in the filter cake and open hole prior to placing the filter cake breaker. To minimise the presence of AIS, a specification of 1.0% v/v maximum was established for the RDF and closely monitored throughout the drilling of the section. Meeting this specification was primarily achieved by implementing an aggressive dump and dilute approach. At section TD and prior to running the completion, the open hole and casing was displaced to a solids-free screen running fluid.



Breaker Treatment Mixing and Pumping

Large volumes of ORCA filter cake treatment fluid were required to ensure complete hole coverage plus an excess to maintain breaker fluid across the formation if losses occurred prior to pulling the wash pipe and closing the Isolation Valve. ORCA breaker was mixed immediately prior to pumping to ensure maximum time before the breaker was activated downhole. A detailed programme was provided and incorporated into the completion programme that included pit management planning, mixing procedures and ORCA QA/QC procedures.

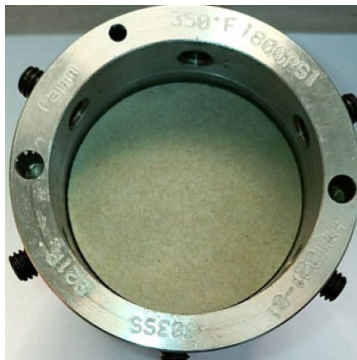
Rigsite Quality Control

QC Testing was performed on the ORCA breaker formulation prior to placement. The test was performed on samples of the active mud system to ensure compatibility and performance. The breaker formulation passed the QC test on each occasion.

ORCA Field QC Test - Before Placement



Filter Cake Before Treatment



Filter Cake Post-Treatment



Disk Post Treatment (Negative Iodine Test for Starch)

Figs 1 – 4 – Photos from Field QC test

ORCA for WBM Breaker FORMULATION

1.14 sg (9.5 ppg) Formulation

Fluid Type	Function	%v/v
1.08 sg NaBr Brine	Carrier Fluid	77.2
ORCA FG3	Acid Precursor	18.6
GBC-1	Buffer/Catalyst	2.6%
Sodium Bicarbonate	pH Control	0.6%
LyoStar	Enzyme Breaker	0.5%
LyoZan	Enzyme Breaker	0.5%



RESULTS

All ten injector wells were completed and treated with ORCA for WBM filter cake treatment. A continuous improvement approach to the project facilitated a successful outcome, with reduced breaker mixing time and ensured 100% coverage of the open hole on seven of the latter eight wells. The exception, (well 7) was due to the loss of fluid to a natural fracture at the toe of the well during the displacement.

Well No.	Open Hole Coverage with ORCA (%)	Max. Loss Rate (bbl/hr)	Total Downhole Losses (bbl)
1	71	140	349
2	8	205	587
3	100	60	127
4	100	136	263
5	100	115	305
6	100	80	286
7*	0	600	1386
8	100	84	202
9	100	45	162
10	100	70	309

Table 3 - ORCA Placement Summary

* Loss zone intersected at toe of well.

The detailed fluid design and technical engineering, bespoke training for rig crew, rigorous QA/QC procedures, nimble logistics assuring timely delivery, plus active engagement in the continuous improvement process on this project are all examples of the contribution of the **Newpark Service Advantage** to project success.