Case History

Application of Engineered Displacement in Offshore North Africa using Avawash™ product series and ClearDepth™ displacement software results in effective casing cleaning, less volume to dispose

An operator in offshore North Africa successfully ran an indirect displacement from SBM to a monovalent NaCl Clear Brine Fluid following Newpark's recommendation of an Engineered Displacement process. This process used lab testing to validate cleaning efficiency of the pills, and lab results checked with ClearDepth™ displacement software.

CHALLENGE	SOLUTION	RESULT
• Displace incompatible fluid: SBM/Brine • Limited tank system to ensure enough surface volume available • Minimize fluid volume to dispose	• Engineered displacement through the use of ClearDepth™ software • Use of Avawash series of products for chemical cleaning • Indirect displacement	• Effective casing cleaning for completion demand • Virtually zero interface contamination • The limited contamination resulted in a small volume for disposal

OVERVIEW

At the end of the drilling operations, an offshore well in North Africa was displaced from SBM @ 1,26 SG to NaCl brine @ 1,16 SG. The complexity of the drilled formation forced the operator to run a low-toxicity SBM in the reservoir, while at the same time to perform the completion, it was necessary that a Clear Brine Fluid based on NaCl be used.

The displacement was performed into cased/liner hole. The completion operation, due to its own nature, required the highest cleanliness of cased-hole to optimize production performance. In order to obtain the best completion results, the decision was made to run Newpark's ClearDepth displacement simulator. This gave the operator a chance to simulate the behavior of the fluid in multiple scenarios, and subsequently, to define the optimal displacement parameters. The displacement was engineered by using detergent pills to obtain the best hole-cleaning results. The displacement was divided in two steps: the first from SBM to unfiltered brine NaCl @ 1,16 SG and then a second step to filtered brine.

This case study is focused on the first displacement from SBM to unfiltered NaCl Brine.

CHALLENGE

The geological characteristics of the formation required the operator to drill the reservoir with a Low Tox SBM. This scenario generated different challenges once the drilling operation was completed due to incompatibility between the NaCl-based Clear Brine Fluid and the Low Tox SBM. The challenges included:

- The SBM created an oil-wet casing, but a water-wet cased hole was required in displacing to the NaCL brine
- There was limited surface volume available, and that created challenges from a tank management standpoint, in particular the availability of clean surface tanks to store the filtered Clear Brine Fluid

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- Due to the different viscosity and density of the two fluids, channeling was one of the main risks associated with such displacement.

SOLUTION

The solutions for these challenges was designed and validated with the ClearDepth software, a Newpark technology tool that can predict displacement results and performances by simulating different scenarios and then defining optimal displacement parameters. This approach led us to design an efficient engineered displacement of pills based on Avawash OBM/LT and Avawash WBM, lab-tested to validate cleaning action. ClearDepth simulations defined flow rates, pressure, anticipated flow regime and contact times. The following parameters were studied with ClearDepth:

1. Displacement was simulated with different flow rates to predict downhole behavior of the different fluids. The most representative were: 900 l/min, 1200 l/min, and 2000 l/min.
2. Each flow rate was tested and studied using different parameters against time during the whole displacement process. The main parameters included:
    - *Flow regime:* Each pill has a function, and to solve this, different flow regimes are required to improve the cleaning effect
    - *Contact time:* The time in minutes that each pill is in contact with a particular surface of the hole. This parameter varies with the pill volume, flow rate and casing diameter.
    - *Pump pressure:* The pressure should never exceed the max pressure of the pump or be low enough to generate back pressure. Moreover, pressure applied reflects on fluid velocity and consequently to the flow regimes.

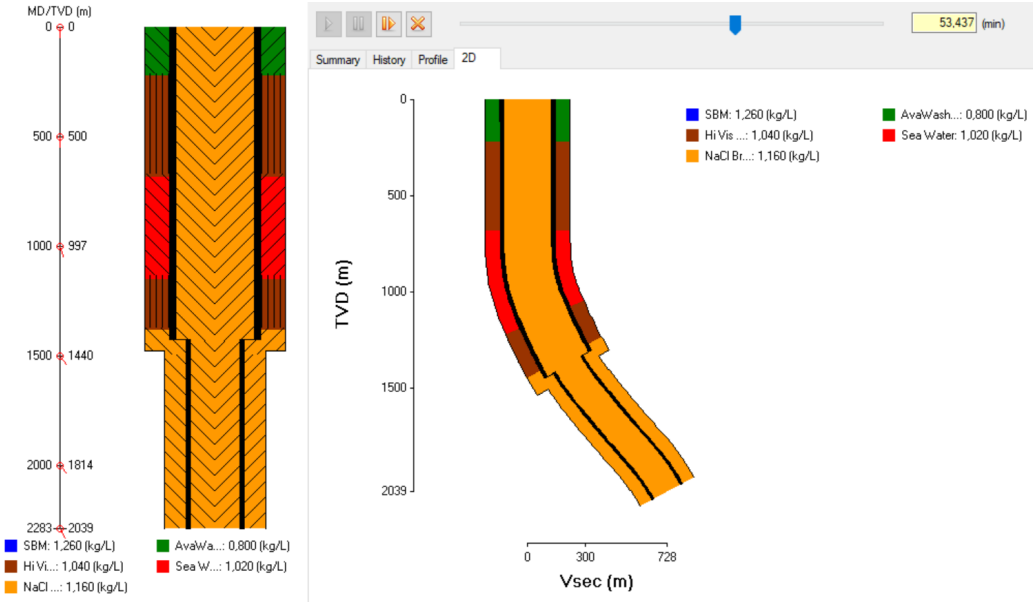

Figure 1 shows the alternance of flow regime of the pills at 1200 l/min. Same regime was observed at 960 l/min and 2000 l/min. NOTE: vertical lines represent laminar flow while Oblique lines represent turbulent flow.

Case History

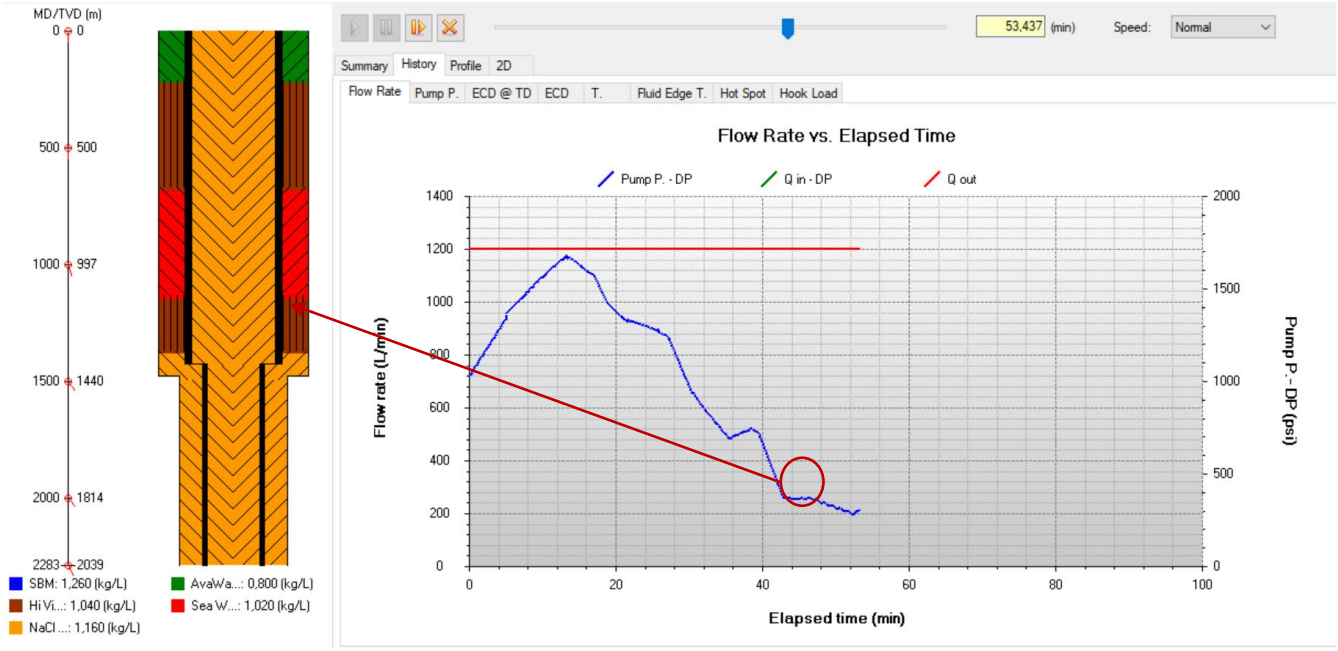

Figure 2: shows that minimum pump pressure with 1200 l/min is 198 psi, that will occur in the moment that second HiVis Avawash WBM pill is totally inside the annulus of 9 5/8" casing. Thanks to the multiple simulations was observed that the minimum acceptable flow rate was of 900 l/min because we noted that pressure drop to zero, that may generate back pressure (see Figure 3).

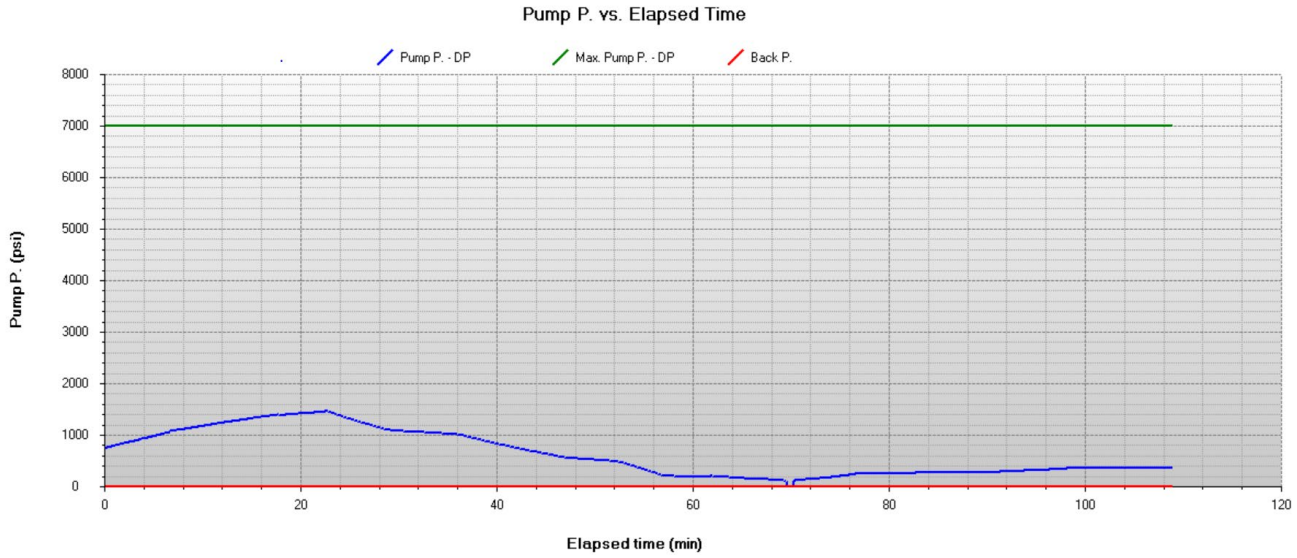

Figure 3: pressure drop to zero at 900 l/min of flow rate when Avawash WBM pill is totally inside the annulus of 9 5/8" casing.

SOLUTION

Based on the study, the operator decided to run the displacement with different displacement flow rates per pill. Below is a chart showing the different pills pumped with the main characteristics and properties, and a comparison of the different pressures detected with ClearDepth against the ones recorded on site.

Pill	Volume (m3)	Density sg	Flow rate (l/min)	Pump pressure (psi) by ClearDepth™	Pump pressure (psi) by Mud logging records
Avawash OBM/SBM	7	0.8	550	550-1160	513-1208
HiVis AVAWASH WBM	10	1,04	1200	1330-2150	1250-2280
Drill water	15	1.01	1250	1550-2150	1560-2190
HiVis AVAWASH WBM	5	1.04	1550	1550-1760	1395-1615
Displace with NaCl unfiltered Brine	---	1,16	2000-2200	1200-2050	1220-2140

Pill specifications

Avawash OBM/LT is a casing cleaner utilized as an effective cleaning agent to remove and wash away residues of oil-based drilling fluid from casing and drill pipe when displacing NAF out of hole to brine or seawater. Avawash OBM may be used undiluted or diluted with base oil. In this case it was used diluted with SBM.

Avawash WBM spacer is a water-based surfactant spacer and a detergent formulated to wash and remove WBM residue from drill pipe, casing and surface equipment. Viscosity was generated by addition of Newpark's Newzan D™ xanthan gum-based product.

RESULTS

During the displacement, only 3m^3 of SBM was contaminated, resulting in the double benefit in terms of low disposal costs and higher volume recovered for the project.

Also during displacement, channeling was not recorded. In terms of hole cleaning performance, once the unfiltered brine was displaced to the filtered one, rig tanks were not fully cleaned, and even in this scenario, the measured turbidity of filtered brine at bottoms up was only 72 NTU.

This reflects the fact that impurity was due to the improper cleaning of the tanks. If the hole was not cleaned properly from SBM residual, the resulted turbidity would be higher.

The filtered Clear Brine Fluid was then circulated through a filtration unit to achieve the required turbidity.