Case History

Engineered Displacement using ClearDepth™ software and Avawash™ products to clean wellbore and minimize interface contamination between SBM and K-Formate-based reservoir drill-in fluids

The project used the detergent and surfactant chemical action of Avawash products to remove, clean and water-wet all downhole metal surfaces. Simulation of the displacement was accurately planned using ClearDepth™ software which worked effectively to detect any possible issues and predict and mitigate challenges that might have occurred during the displacement operations.

CHALLENGE	SOLUTION	RESULT
• Displace incompatible fluids: SBM/RDF • Minimize contamination between fluids • Avoid fluid channeling	• Avawash series cleaning product • Specific lab test to validate formulation efficiency, compatibility, and contact time • ClearDepth software to plan, predict, and mitigate challenges	• Effective casing cleaning • Virtually zero interface contamination • No fluids channeling occurred

OVERVIEW

In an onshore Southern European field, the operator wanted to perform a displacement between a LowTox SBM and a Brine-Based Reservoir Drill-In Fluid.

Due to the high tectonic stress in the area, the RDF was built up at 1,59 SG utilizing a high-density Potassium Formate Clear Brine Fluid base. Due to the high cost of these two fluids and because this was an exploration campaign, it was necessary to minimize contamination during displacement, as well as recovering and re-using both fluids.

A dedicated train of pills was needed to separate, clean, carry to surface and water-wet the metal surfaces. The methodology was designed, lab-tested in the Newpark Technology Center in Katy, Texas, validated by a hydraulic displacement model, and finally approved by the operator.

The results obtained from the intensive lab work were utilized as input data for a displacement simulation run with ClearDepth software. As a result, we were able to define flow rates, check flow regimes and contact time and confirm that with these conditions, the displacement process was possible.

CHALLENGE

Drilling the intermediate section required an SBM weighted up with Barite to 1,93 SG, while the reservoir section need to be drilled with a K-Formate based RDF with a density of 1,59 SG.

A good separation was required between the two fluids to recover and reuse the SBM and to avoid the component of the SBM that would contaminate the RDF, potentially affecting the productivity of the field. The main challenge expected was fluid channeling that could result in

high interface contamination of the expensive fluids, which would then require disposal.

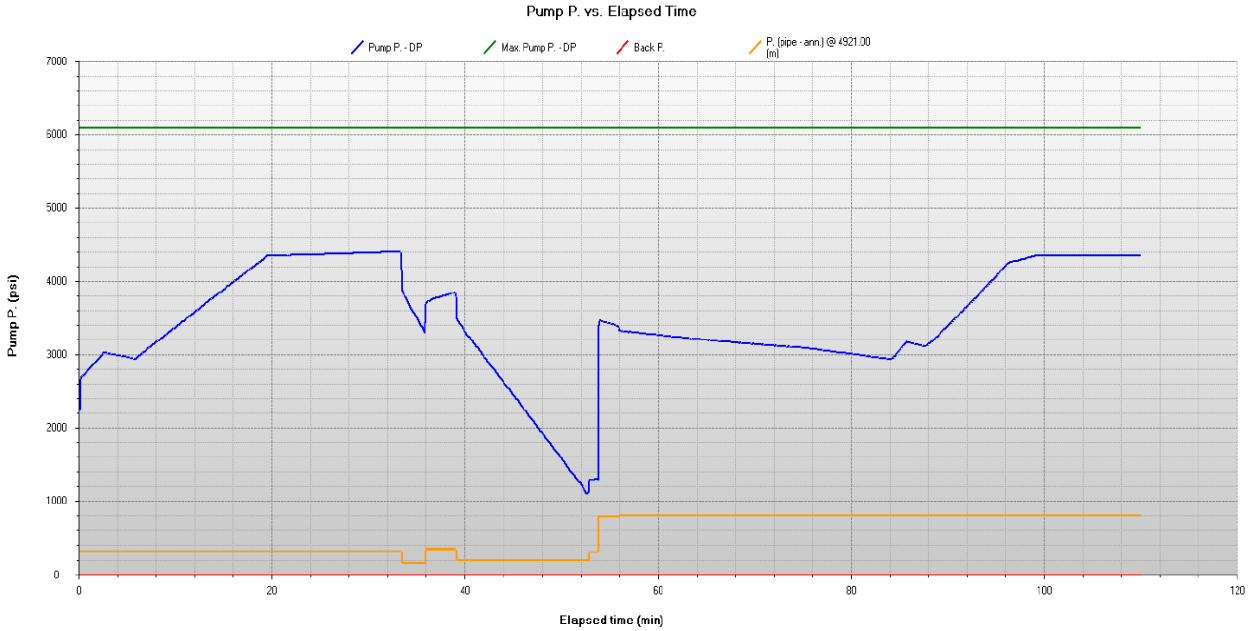
SOLUTION

In order to mitigate the challenges, Newpark used two steps: the first was to design the most appropriate pills in the laboratory, verifying chemical compatibility and then test them through FANN 35 to validate the cleaning efficiency with the SBM. This resulted in a dedicated formulation per pill based on Avawash OBM/LT (Low-Tox Solvent) and Avawash WBM.

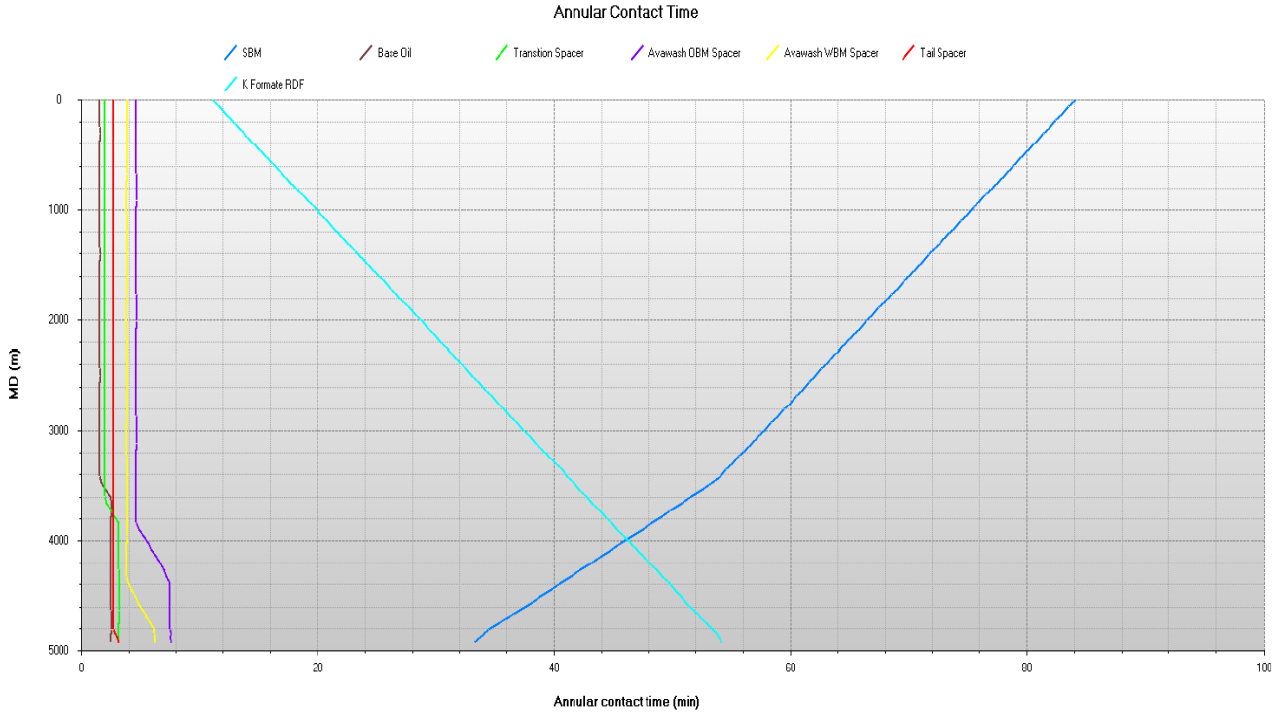
The pills were formulated to provide an alternative between HiVis pills in laminar flow and LoVis pill characterized by a turbulent flow regime. A turbulent regime helps to remove cake from the casing surface while a HiVis, in a laminar regime, will avoid channeling of different fluids.

The results and rheologies obtained in our lab were used as input data for the simulation with the ClearDepth software. As a result, we were able to find the best displacement parameters in terms of the volume of pills, flow rates, flow regime, pressures, and contact time.

Below is an example of the output from our ClearDepth software:



Graph 1: *The above graph shown the trend of the Pump pressure (blue line) during the displacement. It also shows the maximum Pump Pressure achievable (green line). It is critical that the blue line does not intersect the green one.*



Graph 2: *The above graph shown the contact time in minutes of the different fluids in the annulus. Focus must be kept in analyzing contact time noted during simulation and compared with the tests of the train of pills in lab.*

The entire surface mud system, including tanks, lines and ditch, were previously emptied and cleaned from any residual of LT-SBM. Then the fluids shown below were mixed and moved into rig tanks to be used in the indicated volume and sequences for the displacement:

Fluid	*Density (SG)*	*Volume (bbl)*
Base Oil	0,8	25
*Transition Spacer	1,75	32
*Avawash OBM Spacer	1,01	75
*Avawash WBM Spacer	1,01	62
*Tail Spacer	1,57	44
K Formate RDF	1,59	1.200

**Transition spacer is viscosified, weighted and contained 15% v/v Avawash OBM/LT.*

**Avawash OBM LT spacer was mixed pure. Avawash OBM LT is a casing cleaner used as an effective cleaning agent to remove and wash away residues of oil-based drilling fluid from casing and drill pipe when displacing OBM out of a cased hole to brine or seawater.*

**Avawash WBM spacer is a water-based surfactant spacer. Avawash WBM detergent is formulated to wash and remove WBM residue from drill pipe, casing and surface equipment.*

**Tail Spacer is a Potassium Formate pill at needed density made with AVA K 157 (liquid pure Potassium formate).*

Below are the flow rates and pressures noted during the displacement of each pill:

- 25bbls of Base Oil at 105gpm,
- 32bbls of 2,01 SG Transition Spacer at 135 gpm, 1300 psi
- 75bbls of 1,0 SG Avawash OBM/LT Cleaning Spacer at 315 gpm, 2400 psi
- 62bbls of 1,0 SG Avawash WBM Cleaning spacer at 260 gpm, 2790 psi
- 44bbls of 1,55 SG Viscosified Tail Spacer at 185 gpm, 2900 psi

Displacement was performed with 1,59 SG Potassium Formate based RDF at 300-400 gpm, resulting in 1.100-1.200 psi

RESULTS

Effective and successful casing cleaning was achieved.

The spacers were observed back at the shakers exactly as per the time/strokes previously planned with the ClearDepth software. No fluids channeling occurred.

Only a small residual fluids contamination of 3 bbls was noted.